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Matsumoto

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(54) **IMAGE FORMING APPARATUS**

(75) Inventor: **Yuzo Matsumoto**, Abiko (JP)

(73) Assignee: **Canon Kabushiki Kaisha**, Tokyo (JP)

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(22) Filed: **Apr. 20, 2007**

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(30) **Foreign Application Priority Data**

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Apr. 3, 2007 (JP) 2007-097891

(51) **Int. Cl.**
B65H 3/14 (2006.01)
G05B 11/28 (2006.01)

(52) **U.S. Cl.** **271/97**; 271/98; 318/599

(58) **Field of Classification Search** 271/97, 271/98; 318/599
See application file for complete search history.

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Primary Examiner—Patrick H Mackey
Assistant Examiner—Ernesto Suarez
(74) *Attorney, Agent, or Firm*—Fitzpatrick, Cella, Harper & Scinto

(57) **ABSTRACT**

A sheet feeding apparatus and an image forming apparatus which can certainly feed sheets without being influenced by an aging change of fan characteristics are provided. An air is blown to sheets stacked on a tray by an air blowing mechanism having a plurality of fans which are independently rotated, thereby loosening the sheets. Prior to starting the feeding of the sheet, rotational speeds of the fans of the air blowing mechanism are controlled so as to be set to target rotational speeds which have been preset every plural fans so that a wind pressure which can loosen the sheets in the driving state of all fans is obtained.

2 Claims, 23 Drawing Sheets

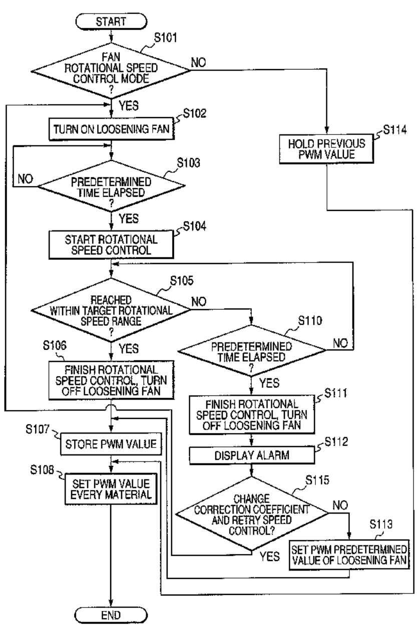
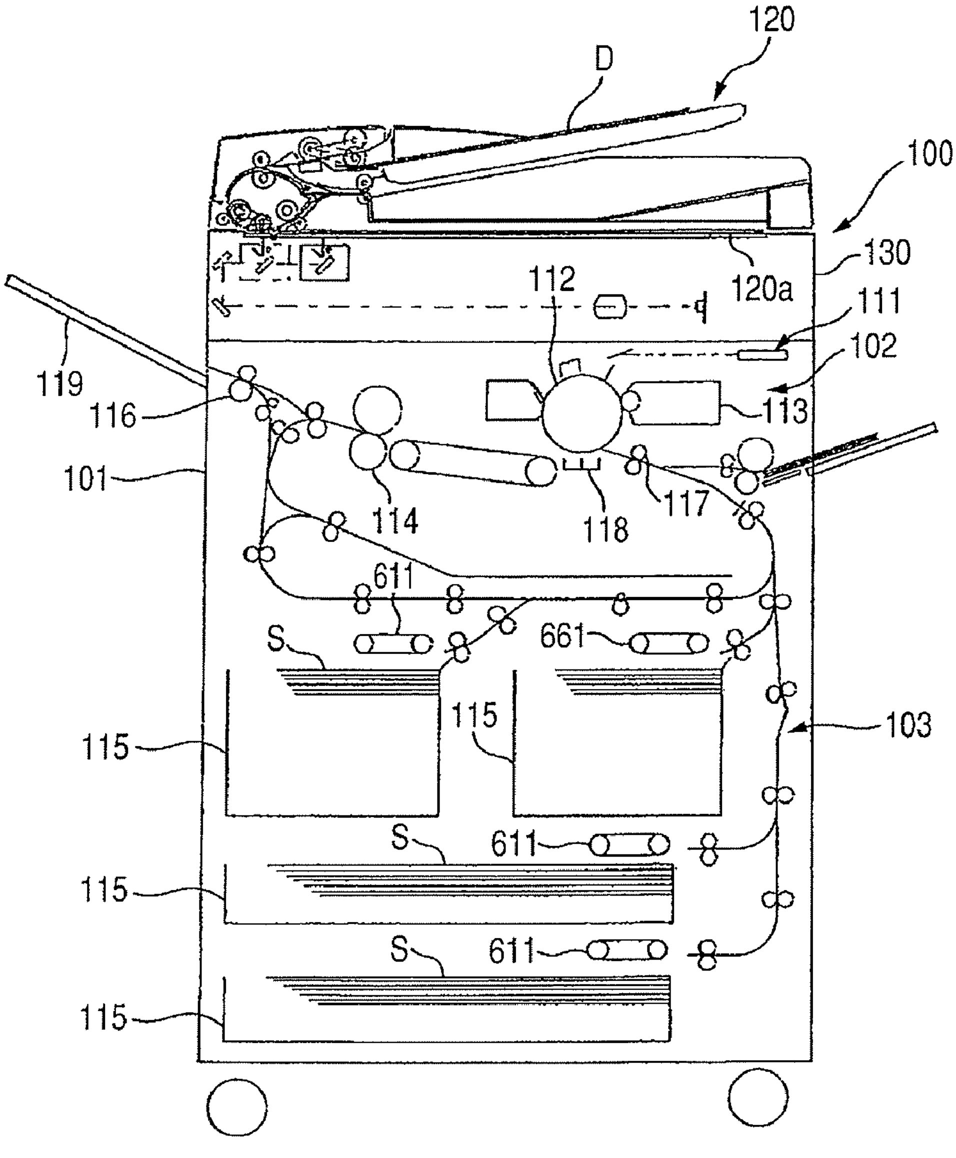


FIG. 1


120
D
100
130
120a
112
111
102
119
116
113
101
114
118
117
611
S
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115
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103
S
611
115
S
611
115

FIG. 2

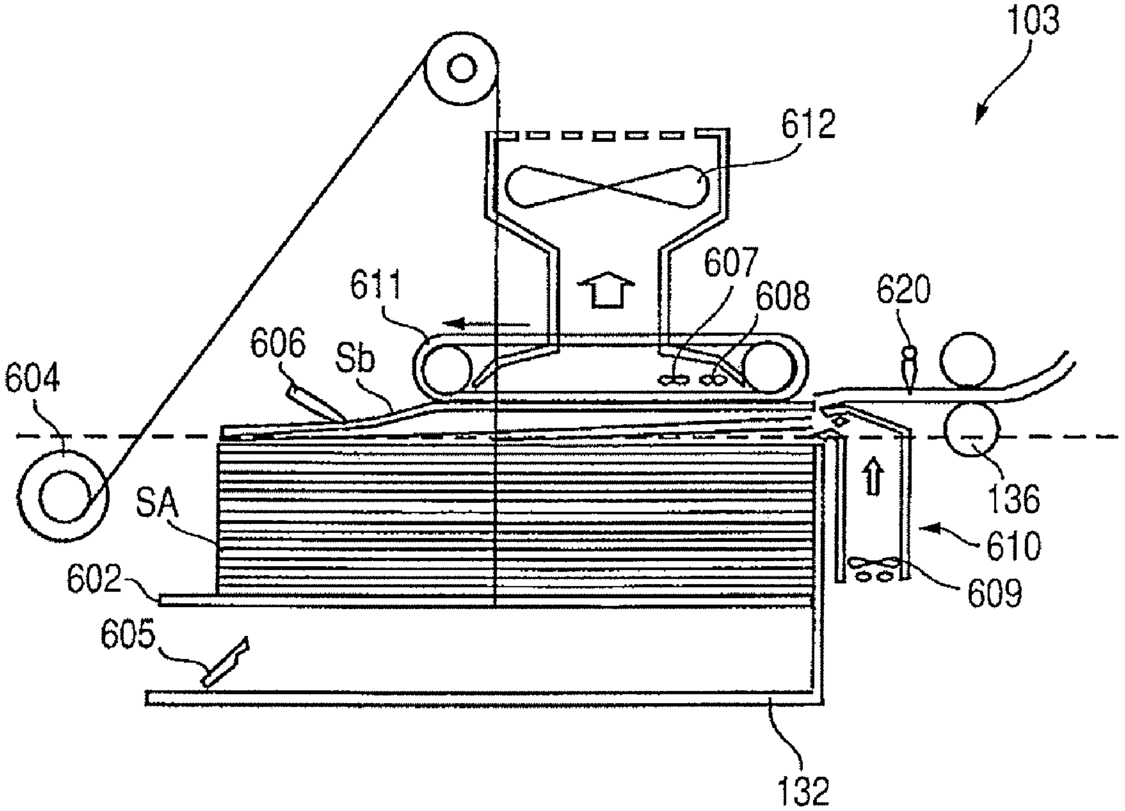

FIG. 3

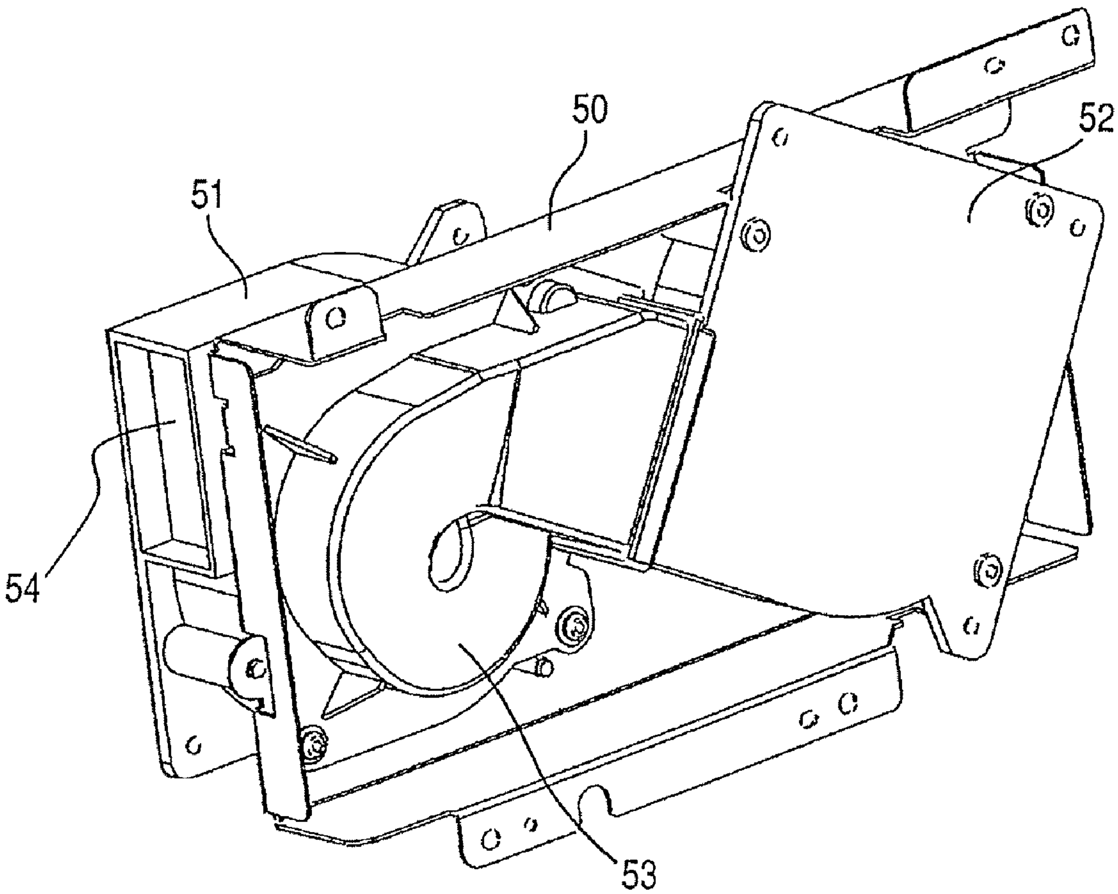

FIG. 4

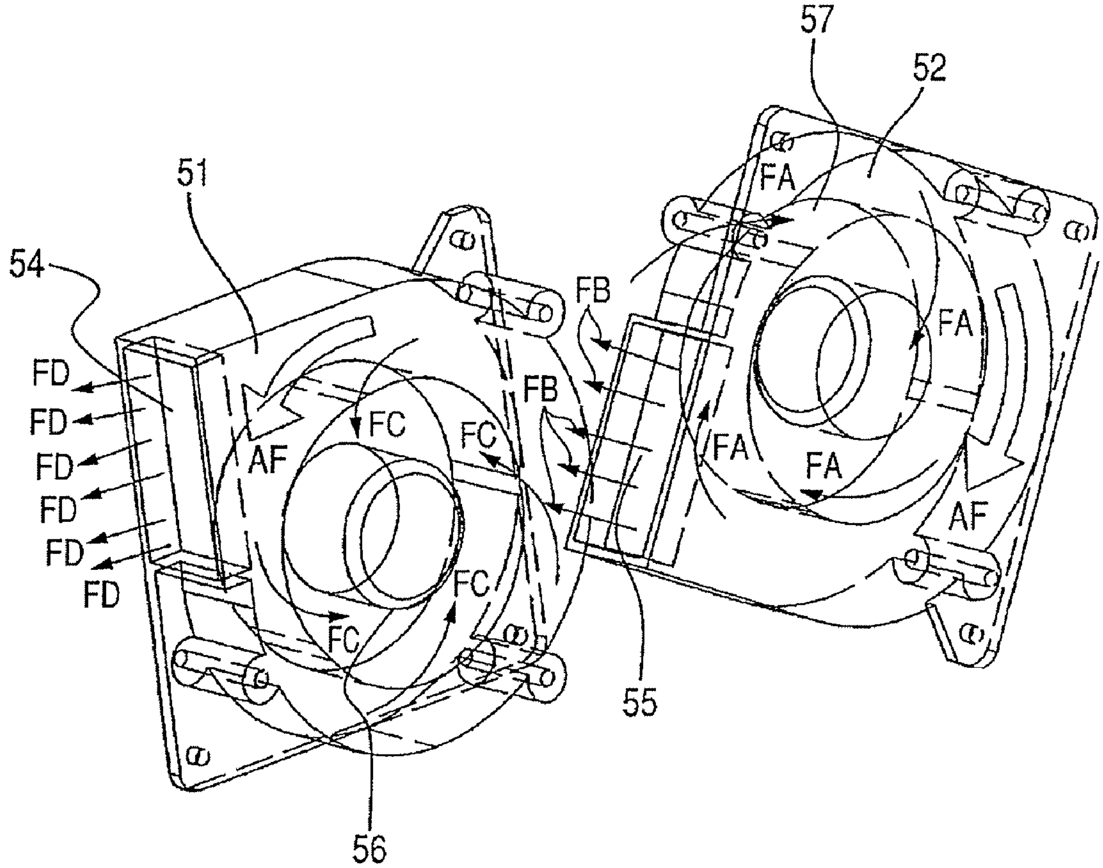

FIG. 5A

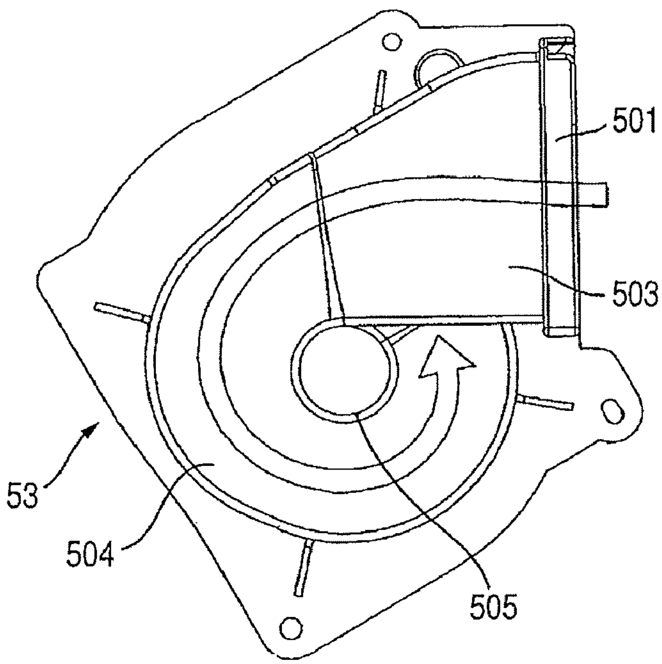

FIG. 5C

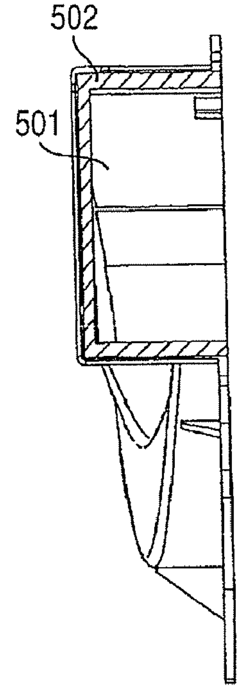

FIG. 5B

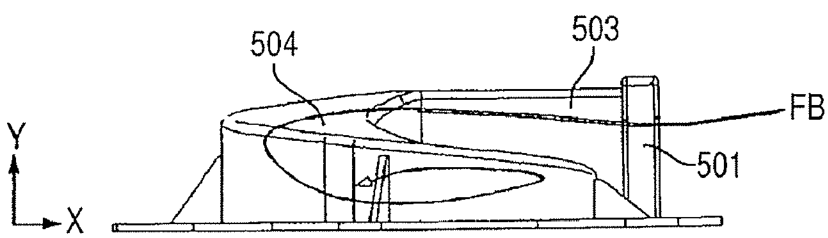

FIG. 6

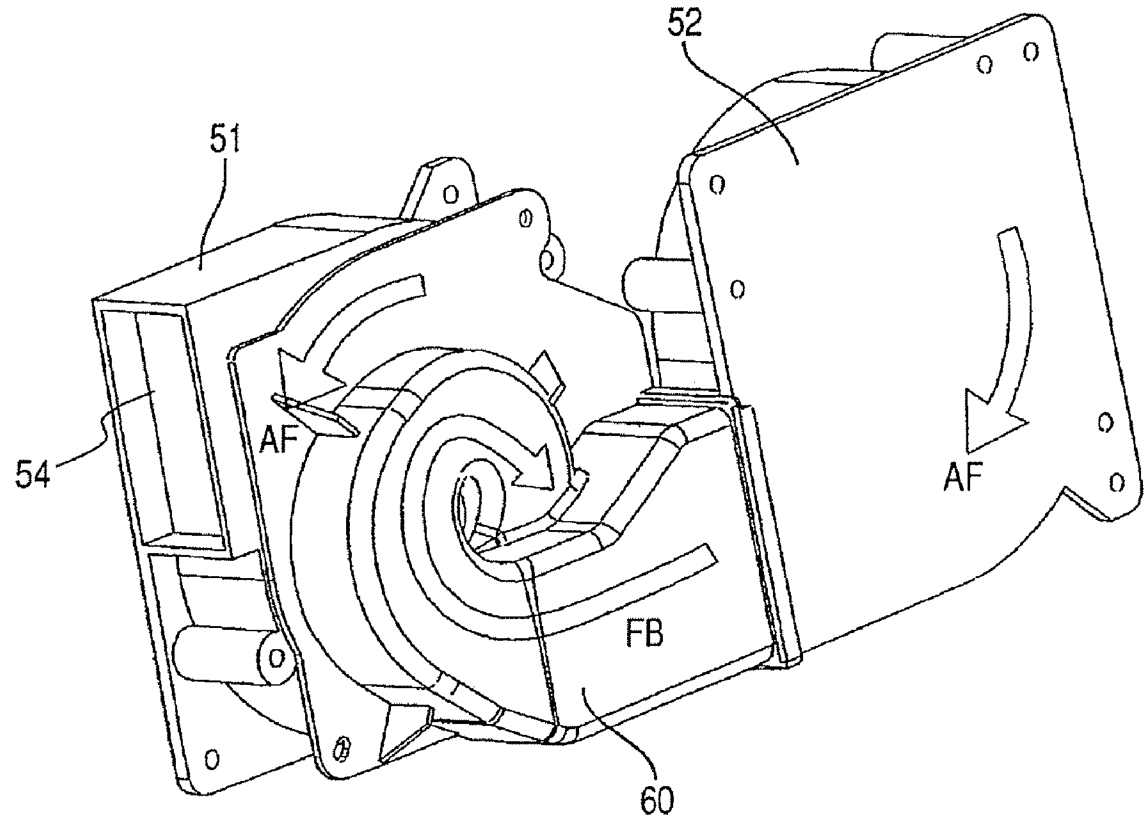

FIG. 7

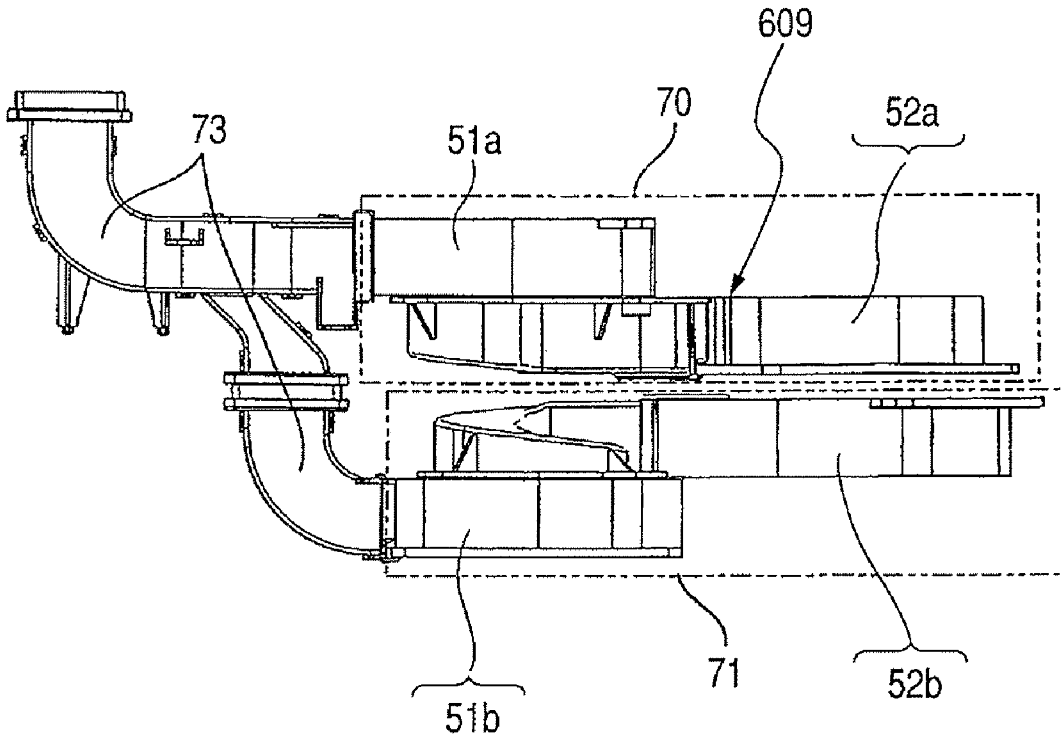

FIG. 8

SPEED CONTROL TARGET VALUE
IN THE CASE OF FOUR FANS

		(Hz)	PWM (%)
1st FAN	TARGET VALUE	182	92%
	TARGET UPPER LIMIT VALUE	184	
	TARGET LOWER LIMIT VALUE	180	
2nd FAN	TARGET VALUE	171	87%
	TARGET UPPER LIMIT VALUE	173	
	TARGET LOWER LIMIT VALUE	169	
3rd FAN	TARGET VALUE	181	91%
	TARGET UPPER LIMIT VALUE	183	
	TARGET LOWER LIMIT VALUE	179	
4th FAN	TARGET VALUE	162	82%
	TARGET UPPER LIMIT VALUE	164	
	TARGET LOWER LIMIT VALUE	160	

⇨ 840 Pa IS REALIZED

FIG. 9

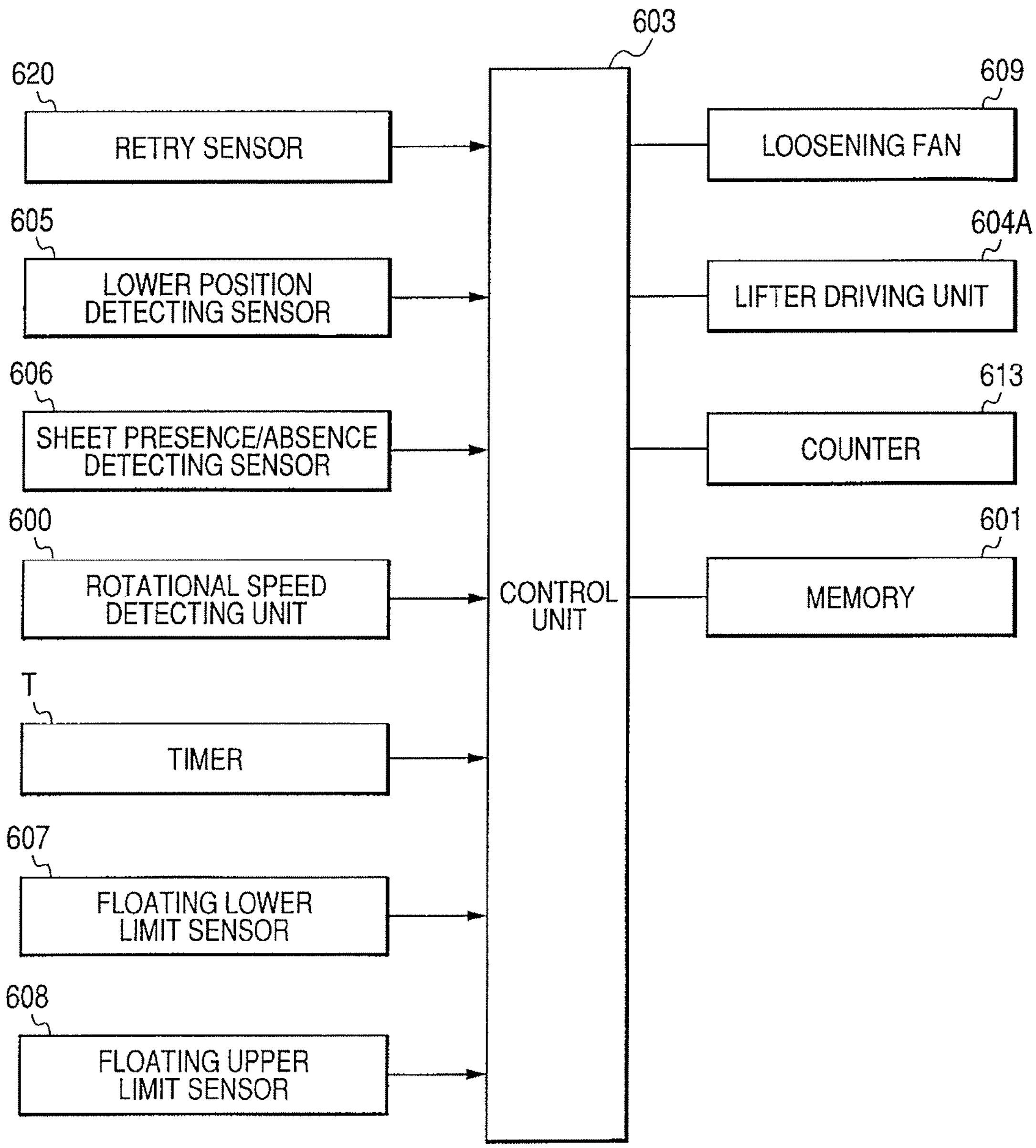
603
620
RETRY SENSOR
605
LOWER POSITION DETECTING SENSOR
606
SHEET PRESENCE/ABSENCE DETECTING SENSOR
600
ROTATIONAL SPEED DETECTING UNIT
T
TIMER
607
FLOATING LOWER LIMIT SENSOR
608
FLOATING UPPER LIMIT SENSOR
CONTROL UNIT
609
LOOSENING FAN
604A
LIFTER DRIVING UNIT
613
COUNTER
601
MEMORY

FIG. 10A

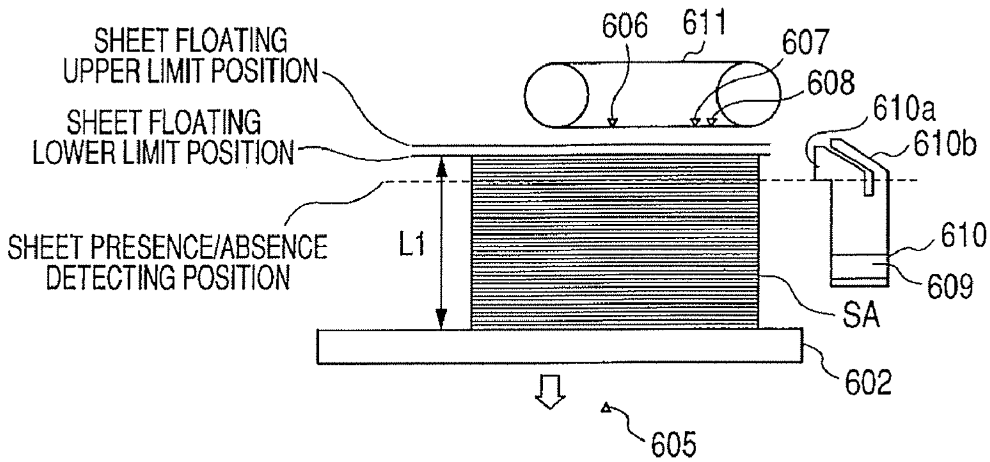

FIG. 10B

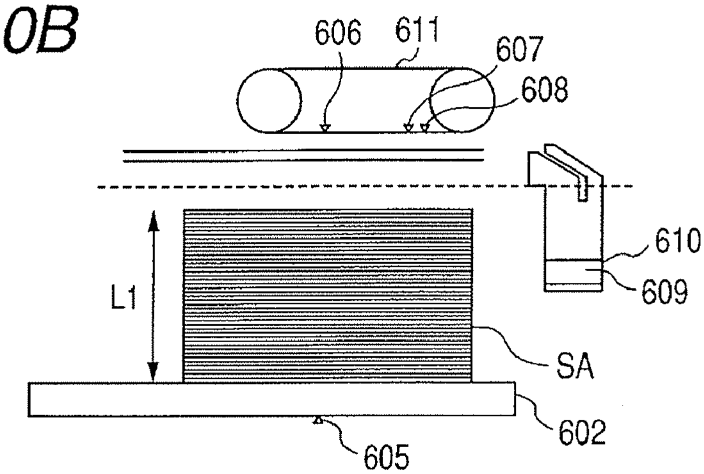

FIG. 10C

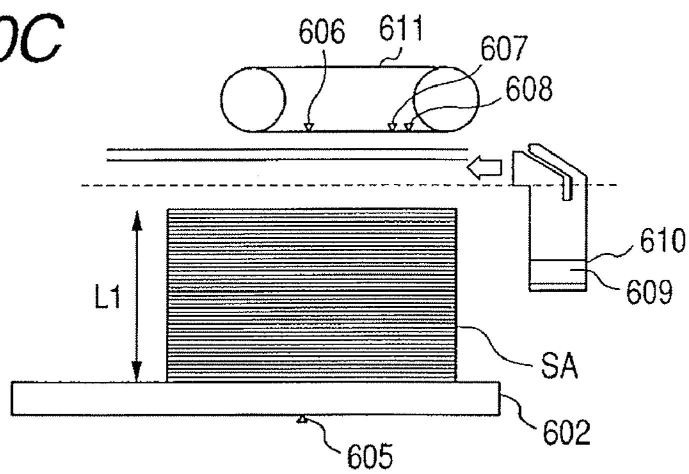

FIG. 11

SHEET BASIS WEIGHT	COEFFICIENT TO ADJUSTMENT VALUE
THIN PAPER	0.25
PLAIN PAPER	0.5
THICK PAPER	0.75
THICKEST PAPER	1.0

FIG. 12

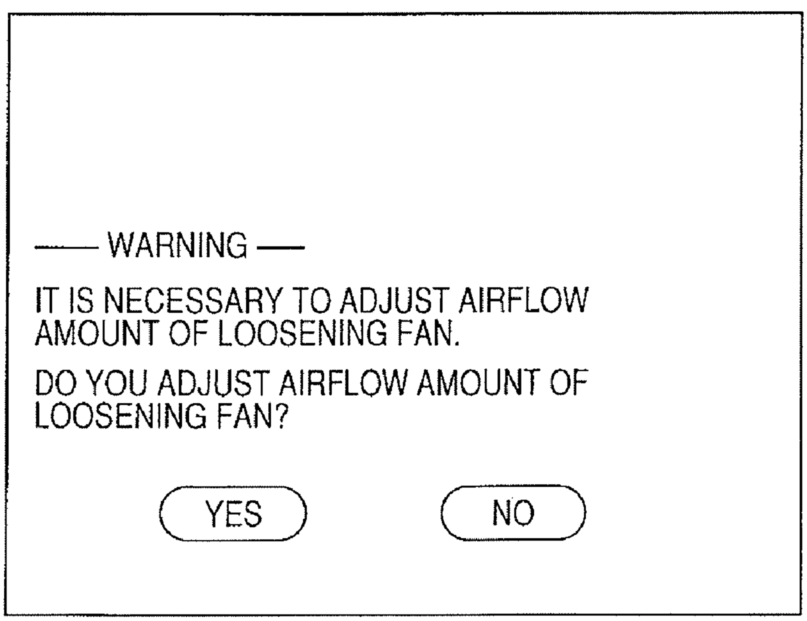

FIG. 13A

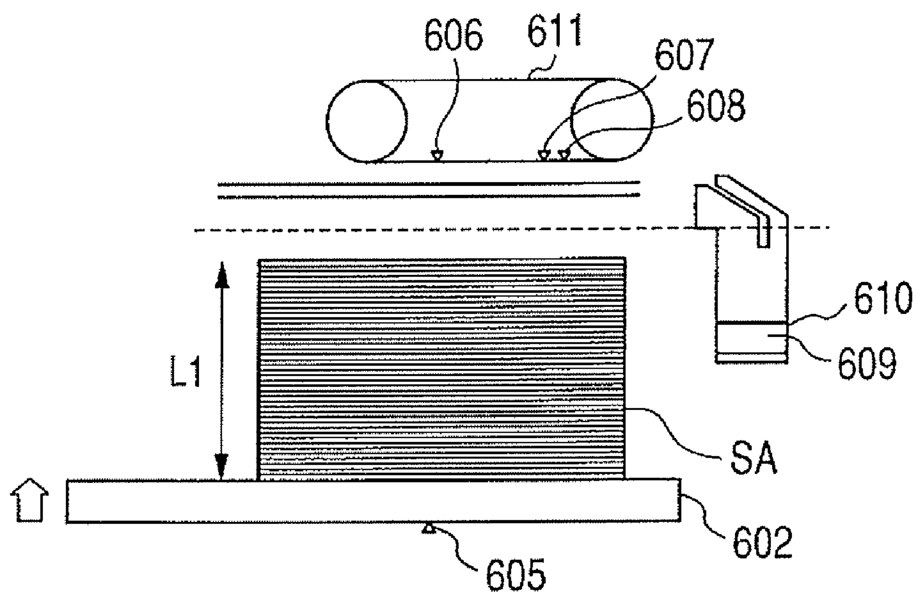

FIG. 13B

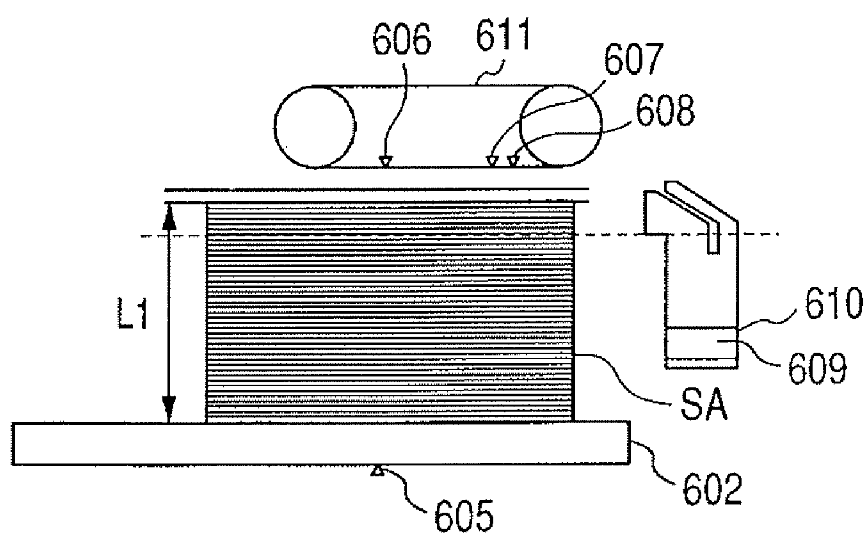

FIG. 14

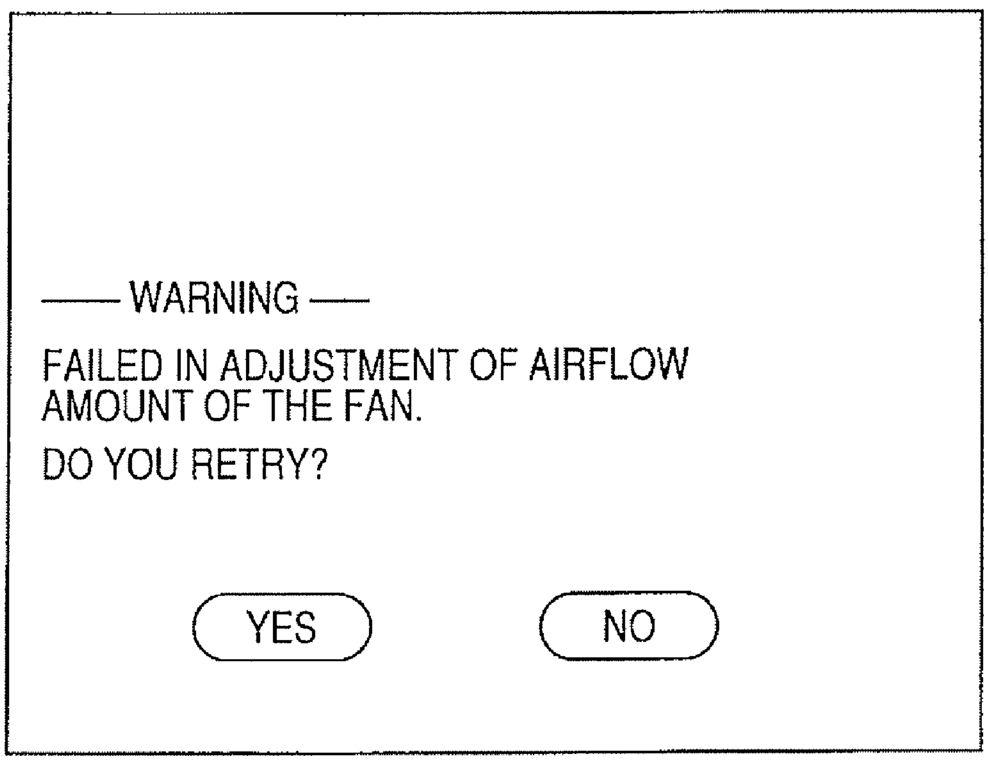
—— WARNING ——
FAILED IN ADJUSTMENT OF AIRFLOW
AMOUNT OF THE FAN.
DO YOU RETRY?
YES
NO

FIG. 15

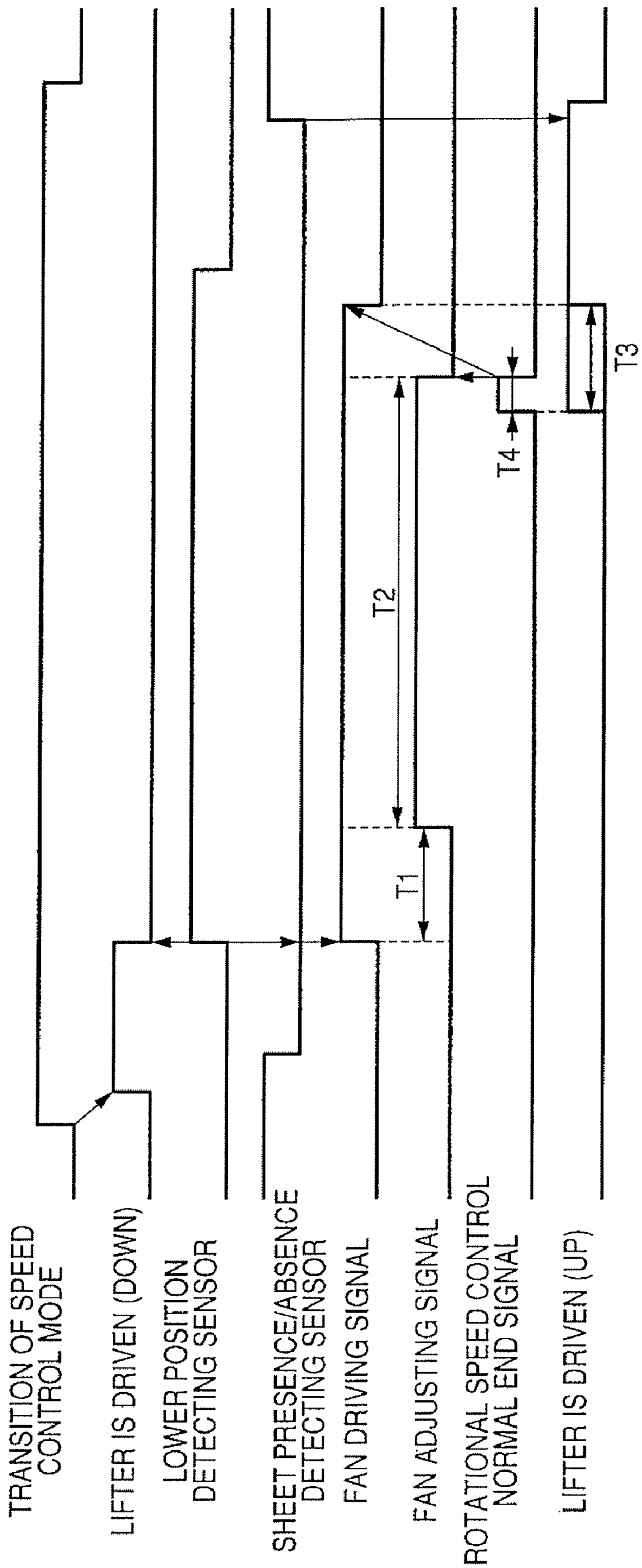
TRANSITION OF SPEED CONTROL MODE
LIFTER IS DRIVEN (DOWN)
LOWER POSITION DETECTING SENSOR
SHEET PRESENCE/ABSENCE DETECTING SENSOR
FAN DRIVING SIGNAL
FAN ADJUSTING SIGNAL
ROTATIONAL SPEED CONTROL NORMAL END SIGNAL
LIFTER IS DRIVEN (UP)
T1
T2
T3
T4

FIG. 16

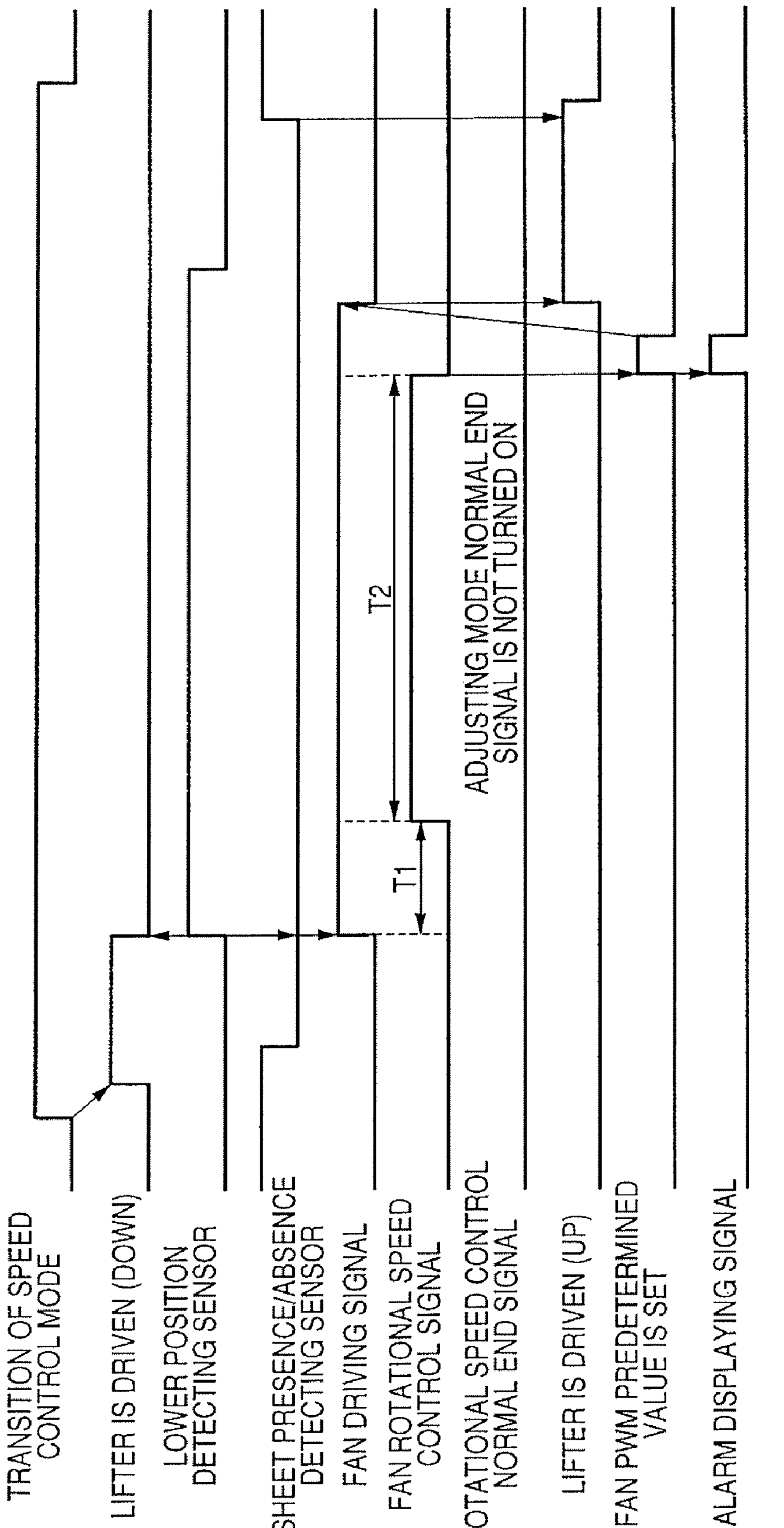
TRANSITION OF SPEED CONTROL MODE
LIFTER IS DRIVEN (DOWN)
LOWER POSITION DETECTING SENSOR
SHEET PRESENCE/ABSENCE DETECTING SENSOR
FAN DRIVING SIGNAL
FAN ROTATIONAL SPEED CONTROL SIGNAL
ROTATIONAL SPEED CONTROL NORMAL END SIGNAL
LIFTER IS DRIVEN (UP)
FAN PWM PREDETERMINED VALUE IS SET
ALARM DISPLAYING SIGNAL
T1
T2
ADJUSTING MODE NORMAL END SIGNAL IS NOT TURNED ON

FIG. 17

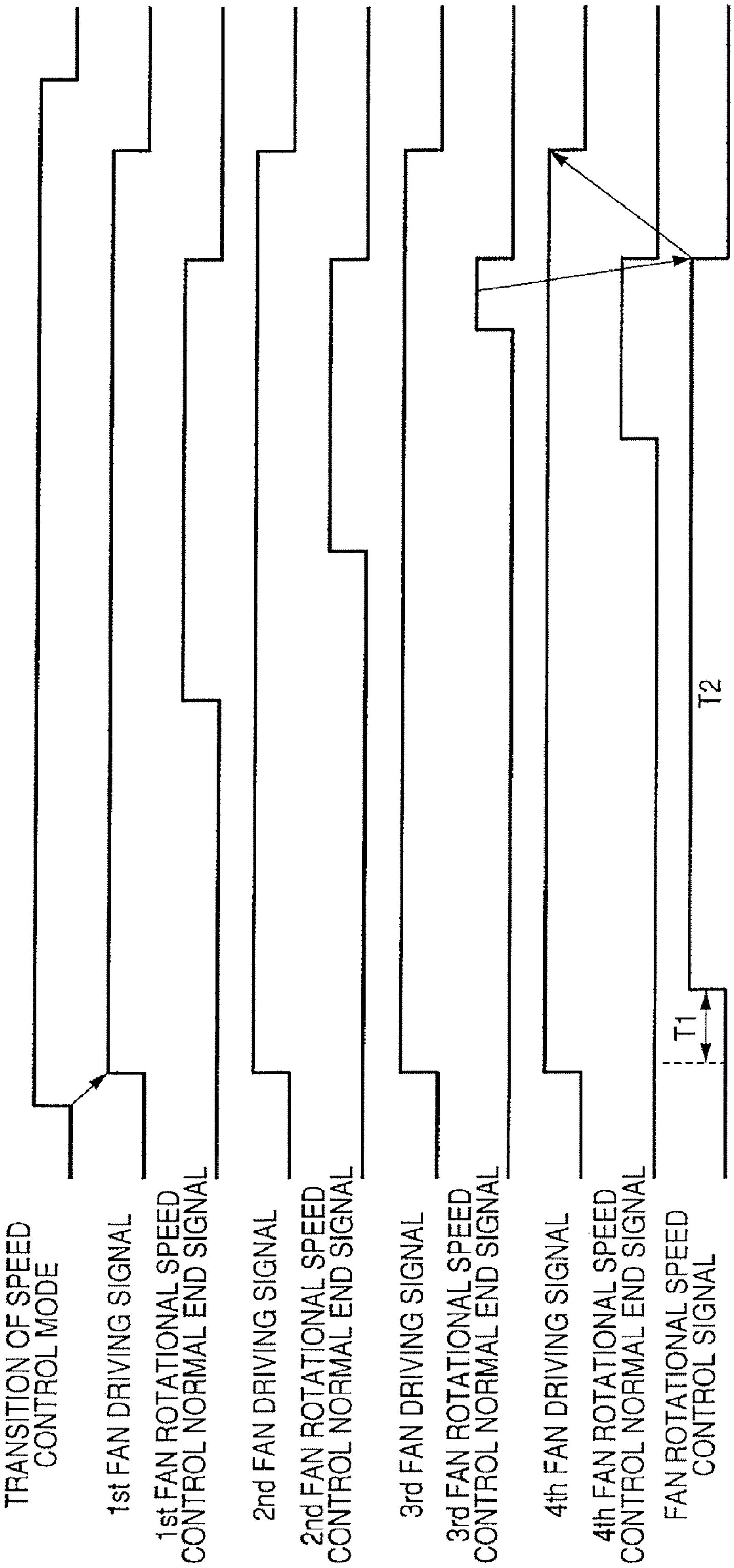
TRANSITION OF SPEED CONTROL MODE
1st FAN DRIVING SIGNAL
1st FAN ROTATIONAL SPEED CONTROL NORMAL END SIGNAL
2nd FAN DRIVING SIGNAL
2nd FAN ROTATIONAL SPEED CONTROL NORMAL END SIGNAL
3rd FAN DRIVING SIGNAL
3rd FAN ROTATIONAL SPEED CONTROL NORMAL END SIGNAL
4th FAN DRIVING SIGNAL
4th FAN ROTATIONAL SPEED CONTROL NORMAL END SIGNAL
FAN ROTATIONAL SPEED CONTROL SIGNAL
T1
T2

FIG. 18

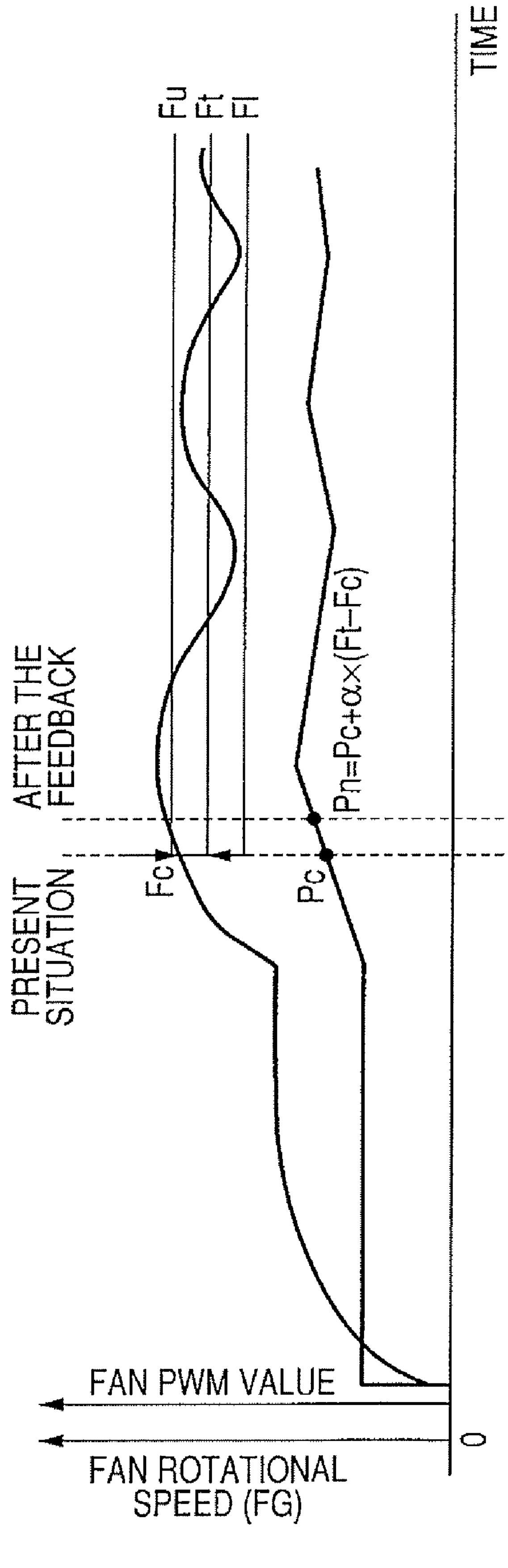
TIME
Fu
Ft
Fl
AFTER THE
FEEDBACK
Pn=Pc+α×(Ft−Fc)
PRESENT
SITUATION
Fc
Pc
FAN PWM VALUE
0
FAN ROTATIONAL
SPEED (FG)

FIG. 19

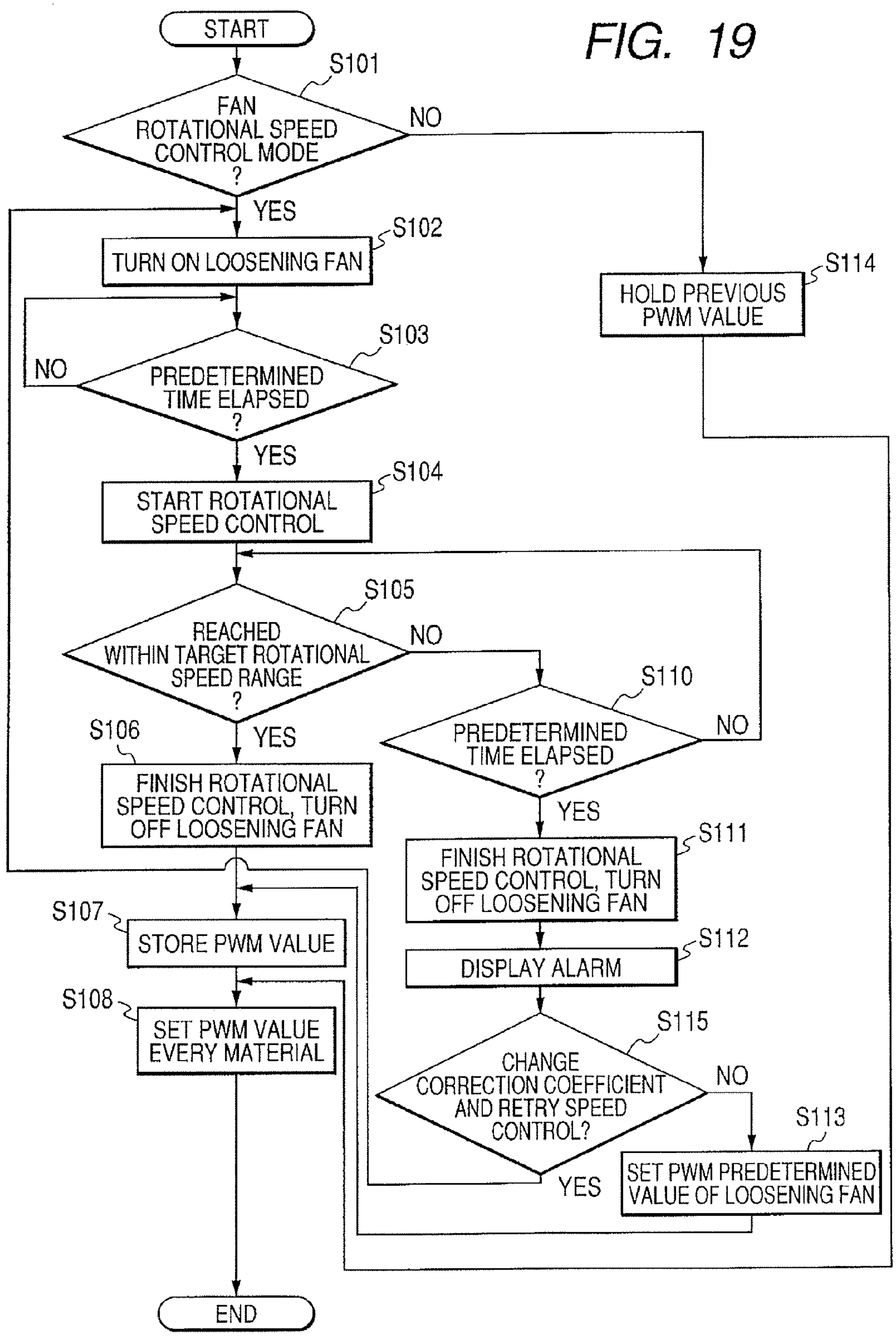
START
S101
FAN ROTATIONAL SPEED CONTROL MODE ?
NO
YES
S102
TURN ON LOOSENING FAN
S114
HOLD PREVIOUS PWM VALUE
S103
NO
PREDETERMINED TIME ELAPSED ?
YES
S104
START ROTATIONAL SPEED CONTROL
S105
REACHED WITHIN TARGET ROTATIONAL SPEED RANGE ?
NO
S110
PREDETERMINED TIME ELAPSED ?
NO
S106
YES
FINISH ROTATIONAL SPEED CONTROL, TURN OFF LOOSENING FAN
YES
S111
FINISH ROTATIONAL SPEED CONTROL, TURN OFF LOOSENING FAN
S107
STORE PWM VALUE
S112
DISPLAY ALARM
S108
SET PWM VALUE EVERY MATERIAL
S115
CHANGE CORRECTION COEFFICIENT AND RETRY SPEED CONTROL?
NO
S113
SET PWM PREDETERMINED VALUE OF LOOSENING FAN
YES
END

FIG. 20

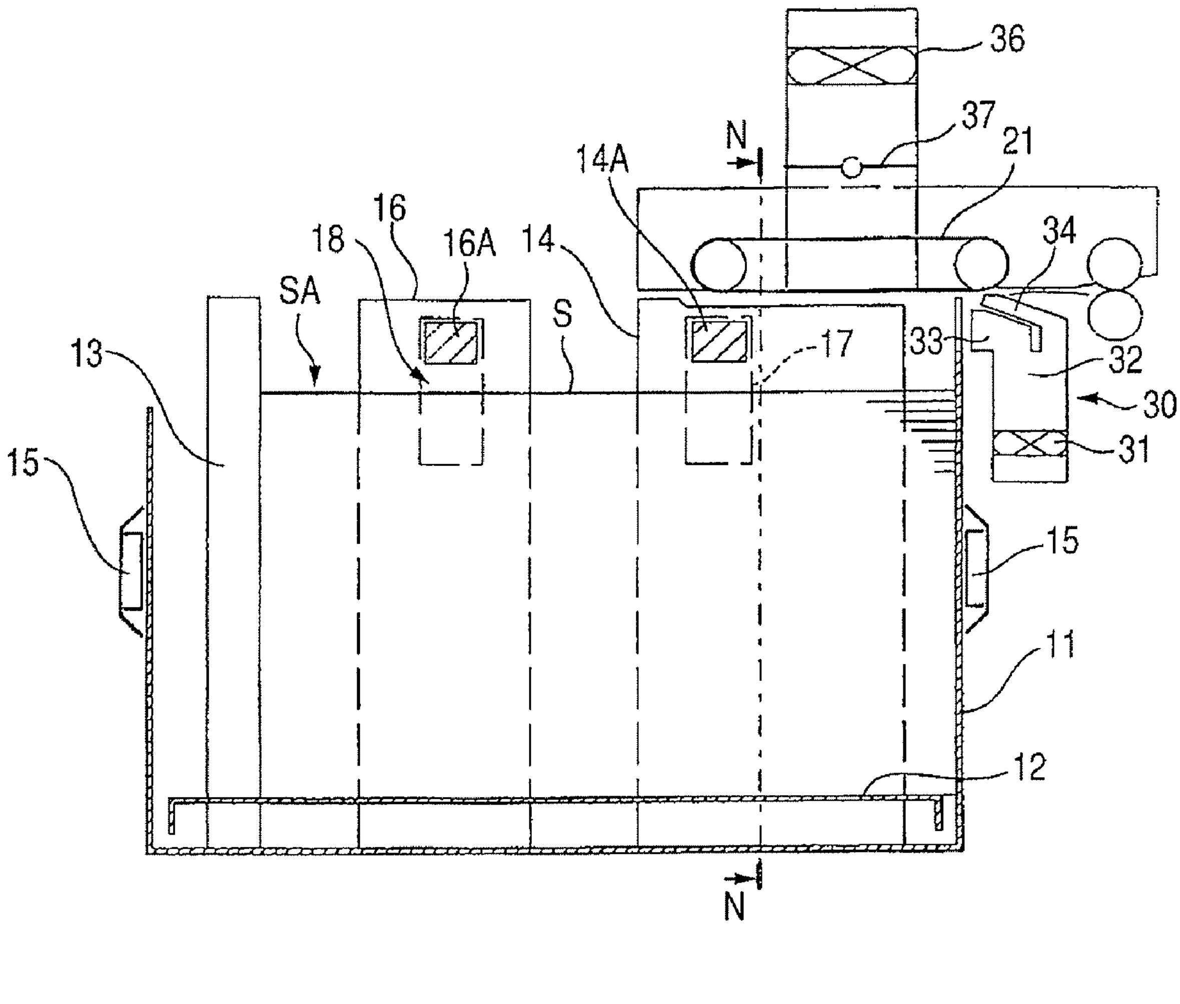

FIG. 21

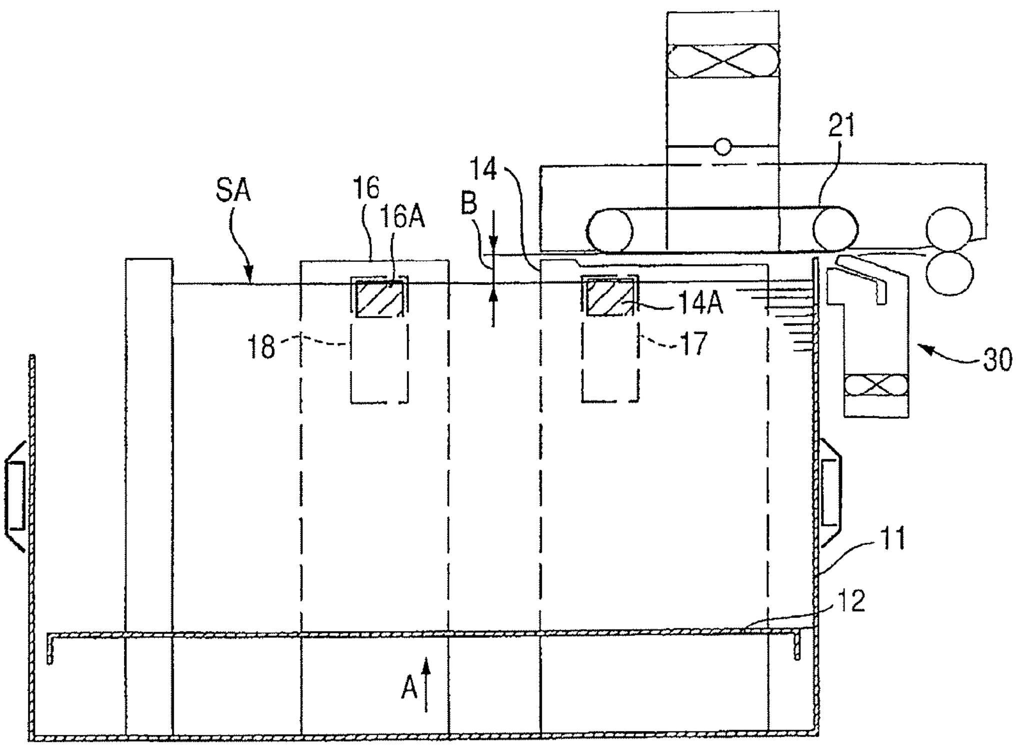

FIG. 22

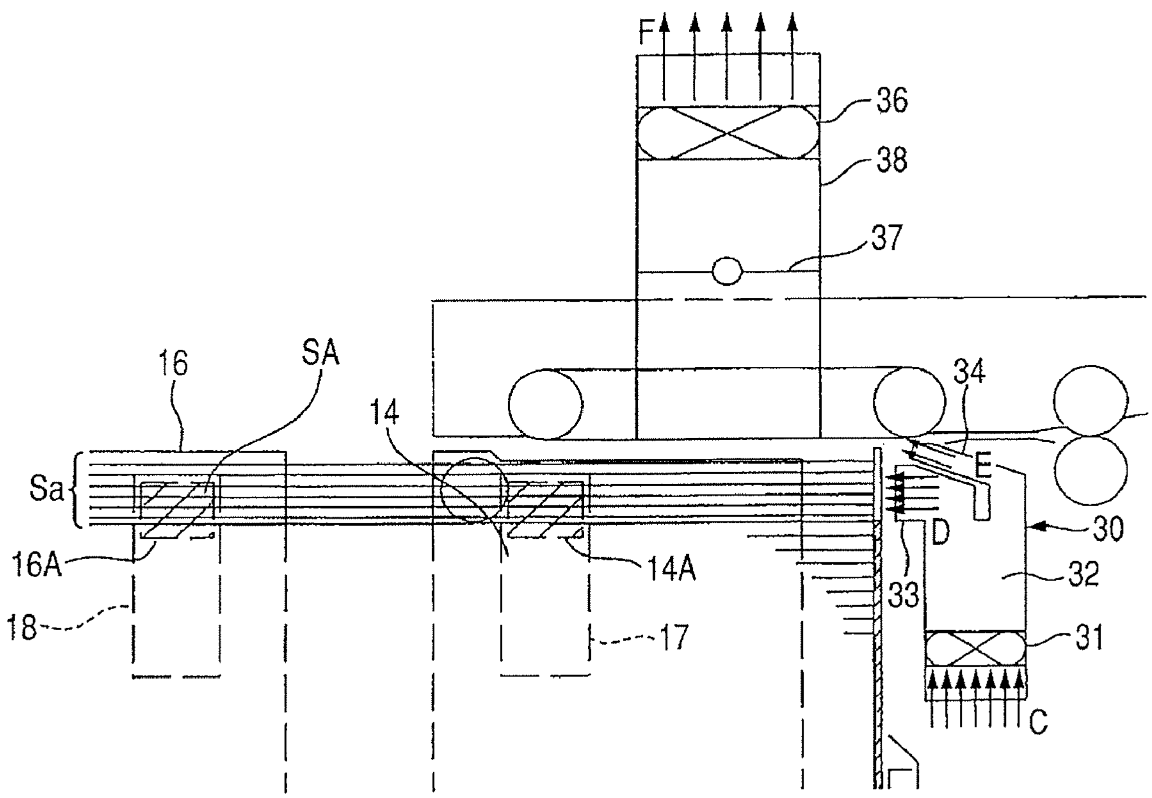

FIG. 23

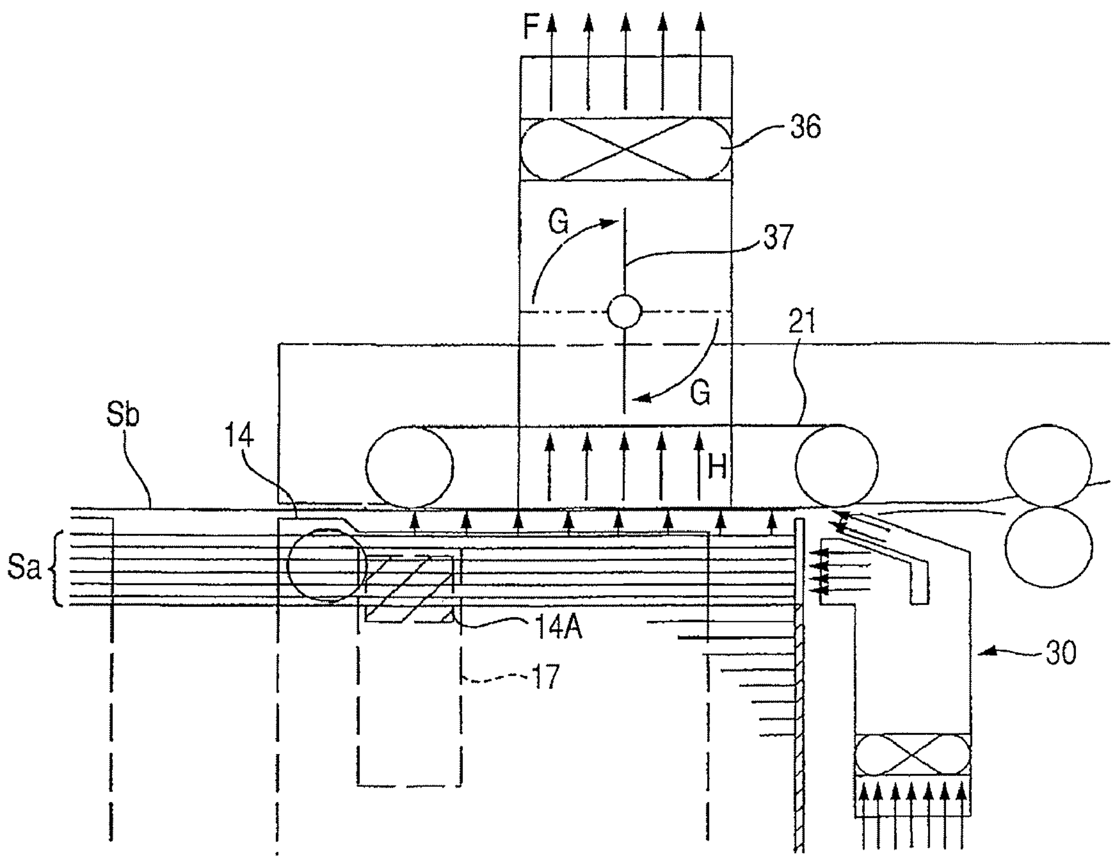

FIG. 24

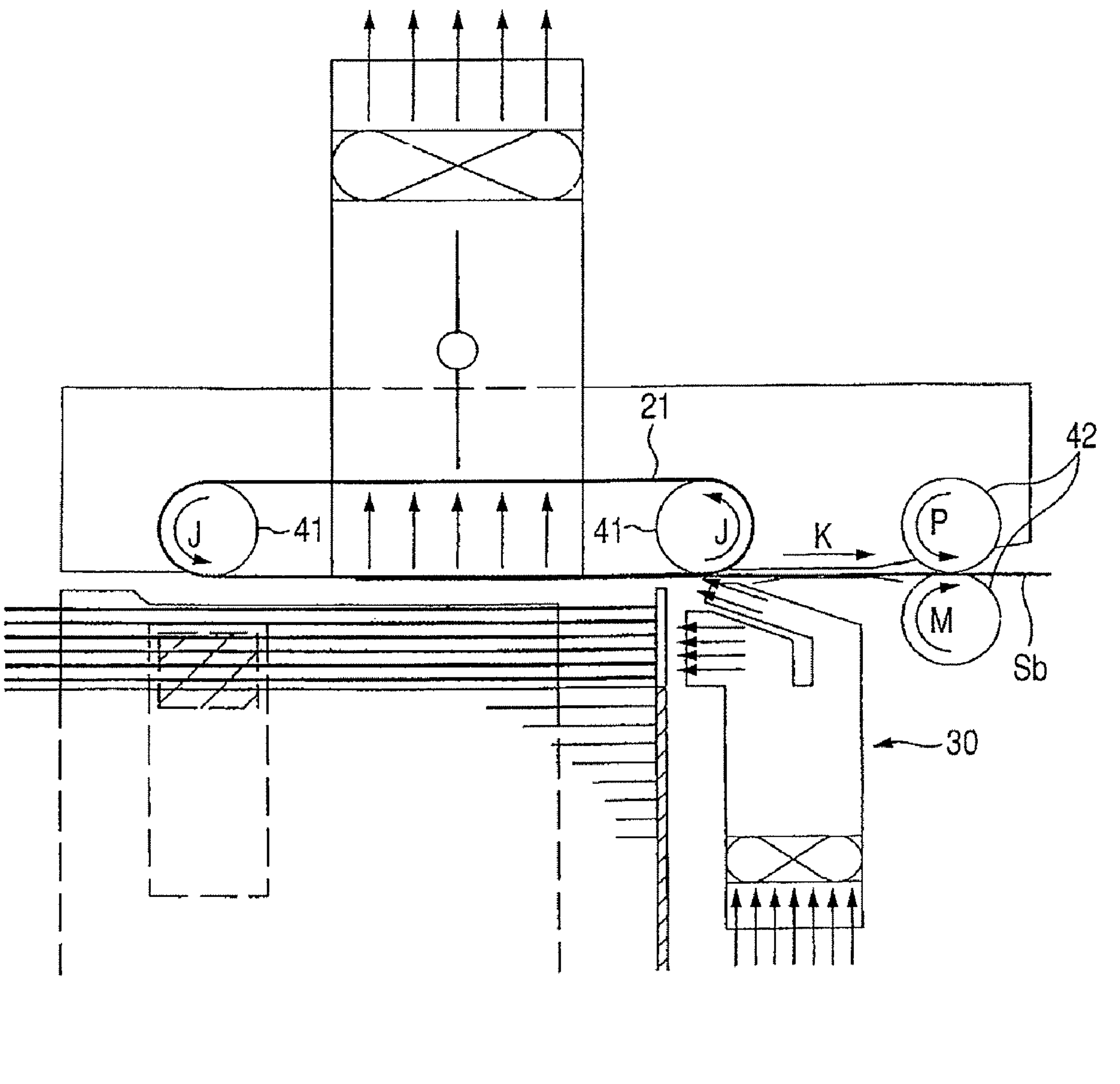

IMAGE FORMING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image forming apparatus having a sheet feeding apparatus for feeding sheets after the air was blown to the sheets and the sheets were loosened.

2. Description of the Related Art

Among conventional image forming apparatuses such as copying apparatus, printer, and the like, there is an apparatus having a sheet feeding apparatus for separating sheets stacked on a tray from the top sheet one by one and feeding them to an image forming unit.

As such a sheet feeding apparatus, as disclosed in Japanese Patent Application Laid-Open No. H07-196187, there is an apparatus of a type in which the air is blown to a sheet bundle stacked on a tray, a plurality of sheets is floated and separated, and thereafter, the sheet is adsorbed to an adsorbing and conveying belt and fed.

FIG. **20** is a cross sectional view illustrating an example of a sheet feeding apparatus with such a construction.

In FIG. **20**, a container **11** is provided for a main body of an image forming apparatus (not shown) so that is can be freely pulled out. Sheets S are enclosed in the container **11**. The container **11** has: a tray **12** which can be freely elevated upward and downward and on which a plurality of sheets S is stacked; and a rear edge regulating plate **13** for regulating a position of a rear edge as an edge on the upstream side in the sheet feeding direction of the stacked sheets S. Further, the container **11** has side edge regulating plates **14** and **16** each for regulating a position of a side edge as an edge in the width direction which perpendicularly crosses the sheet feeding direction of the stacked sheets S. A slide rail **15** which is used to pull out the container **11** from the image forming apparatus main body (not shown) is provided between the image forming apparatus main body and the container **11**.

In FIG. **20**, an adsorbing and conveying belt **21** adsorbs the sheet and feeds it. An adsorbing fan **36** allows the sheet S to be adsorbed to the adsorbing and conveying belt **21**. An air blowing portion **30** blows the air to a front edge of an edge portion on the downstream side in the sheet feeding direction of a sheet bundle SA. The air blowing portion **30** has a separating fan **31**, a separating duct **32**, a loosening nozzle **33**, and a separating nozzle **34**. The air blown out by the separating fan **31** is blown toward the sheets from the loosening nozzle **33** and the separating nozzle **34** through the separating duct **32**.

In the sheet feeding apparatus with such a construction, when the user pulls out the container **11**, sets the sheets S therein, and thereafter, stores the container **11**, the tray **12** is lifted up by a driving unit (not shown) in the direction shown by an arrow A in FIG. **21**. The tray **12** is stopped at a position where a distance between an upper surface of the sheet bundle SA and the adsorbing and conveying belt **21** is equal to B and, thereafter, prepares for a feeding signal.

Subsequently, when the feeding signal is input, the separating fan **31** of the air blowing portion **30** is made operative and sucks the air in the direction shown by arrows C in FIG. **22**. The air is blown toward the front edge surface of the sheet bundle SA from the loosening nozzle **33** and the separating nozzle **34** through the separating duct **32** in the direction shown by arrows D and E, respectively. Thus, a few upper sheets Sa in the sheet bundle SA float and are loosened. On the other hand, the adsorbing fan **36** is made operative and blows the air in the direction shown by arrows F in FIG. **22**. At this time, an adsorbing shutter **37** provided for an adsorbing duct **38** is closed.

Auxiliary separating fans **17** and **18** are attached to the side edge regulating plates **14** and **16**, respectively. The air from the auxiliary separating fans **17** and **18** is blown to side edges of the sheet bundle SA from openings **14**A and **16**A. By providing the auxiliary separating fans **17** and **18** as mentioned above, the floating and separation of the sheets Sa are more certainly performed.

Subsequently, when a floating state of a plurality of floating sheets Sa is stabilized after the elapse of a predetermined time after the feeding signal had been input, the adsorbing shutter **37** is rotated in the direction shown by arrows G as shown in FIG. **23**. Thus, a sucking force in the direction shown by arrows H is generated by the adsorbing fan **36** from a hole for sucking (not shown) formed in the adsorbing and conveying belt **21**. A top sheet Sb in the floating sheets Sa is adsorbed to the adsorbing and conveying belt **21**.

By rotating a belt driving roller **41** in the direction shown by arrows J shown in FIG. **25**, the sheet is conveyed in the direction shown by an arrow K. Further, the sheet is conveyed to a conveying path on the downstream side by a pulling-out roller pair **42** which is rotated in the direction shown by arrows M and P.

In the sheet feeding apparatus, a degree of ease upon floating of the sheet differs depending on a material (thickness and weight) of the sheet. Therefore, a rotational speed of the separating fan **31** is controlled according to the material of the sheet so as to obtain the optimum floating amount, thereby adjusting a wind pressure of the air which is blown. For example, if the sheet is made of one of a thin material and a light material, the control is made so as to decrease the rotational speed of the separating fan **31**. If the sheet is made of one of a thick material and a heavy material, the control is made so as to increase the rotational speed of the separating fan **31**. Such a technique has been disclosed in Japanese Patent Application Laid-Open No. 2005-96992.

There has also been proposed such a technique that the material (thickness and weight) of the sheets stacked on the tray **12** is input from an operating unit of the image forming apparatus, thereby controlling so that the air is blown by a predetermined blowing amount according to the input material of the sheet.

In recent years, in association with the realization of a color image in the image forming apparatus, what is called coating paper in which the surface of the sheet has been coated with a coating material as a sheet for color printing is often fed. In the case of such coating paper, there is a case where a force (adsorbing force) by which the sheets are mutually adhered is equal to 10N or more depending on a temperature or a humidity of a use environment.

When such coating paper is separated and fed, in the conventional image forming apparatus in which by blowing the air to the sheet bundle, the sheets are separated and fed, there is a case where such a double feeding that the sheets are conveyed in the overlapped state occurs. Further, there is also a case where ten or more sheets are fed in a lump and a paper jam occurs in the conveying path.

To float the heavy and large sheets whose basis weight is equal to or larger than 200 g/m^2, even if it is assumed that there is not an influence of the adsorption between the sheets as mentioned above, a very large wind pressure is necessary in order to simply float. Further, for example, in the case of conveying the sheets of the A4 size at a rate of about 70 to 100 sheets per minute, a time which is necessary for the loosening and separation per sheet (that is, a time which is necessary until the sheet is stably floated) becomes short and there is a risk that the sheet cannot be sufficiently loosened.

A compressor, a large turbo fan, a scirocco fan, or the like is often used as an air blowing portion **30** so that the air of a high pressure can be generated. However, they are typically large, heavy, and high in costs. There is, consequently, a risk of causing a large size, a high price, and the like of the apparatus.

On the other hand, for example, in the case where the coating paper of the A3 size of 200 g/m^2 are loosened and conveyed at a rate of 50 sheets per minute in an environment of a room temperature of 30° C. and a relative humidity in a range from 60 to 80%, it has been found from experimental results that the air blowing portion **30** needs to have an ability of accomplishing a wind pressure of 650 Pa (pascal).

Among scirocco fans which are used in the sheet feeding apparatuses of the image forming apparatuses such as a copying apparatus which can output the sheets of the A4 size at a rate of about 50 to 70 sheets per minute and the like, a diameter of impeller of the relatively large scirocco fan is within a range about from 80 to 120 mm. According to such a scirocco fan, the air of the pressure which is fairly higher than that of an axial-flow fan having the same diameter is obtained. However, if the impeller having the diameter of, for example, 120 mm is attached to the air blowing portion **30**, the wind pressure of up to about 420 Pa is obtained.

SUMMARY OF THE INVENTION

The invention is made in consideration of such a present situation and it is, therefore, an object of the invention to provide an image forming apparatus which can loosen sheets at an optimum wind pressure by using a small and reasonable fan and can certainly feed them.

According to the invention, there is provided an image forming apparatus having a sheet feeding apparatus for blowing an air to sheets stacked on a tray, loosening the sheets, and feeding the loosened sheet toward an image forming unit, comprising: an air blowing mechanism constructed by combining a plurality of fans in order to blow the air to the sheets stacked on the tray, a control unit which controls the air blowing mechanism so as to form a set wind pressure by combining the plurality of fans, the control unit controlling rotational speeds of at least two of the plurality of fans, individually.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram illustrating a schematic construction of a printer as an example of an image forming apparatus according to an embodiment of the invention.

FIG. **2** is a diagram for describing a construction of a sheet feeding apparatus provided for the image forming apparatus.

FIG. **3** is a diagram illustrating a construction of a loosening fan provided for the sheet feeding apparatus.

FIG. **4** is a diagram for describing a flow of an air of two scirocco fans constructing the loosening fan.

FIGS. **5**A, **5**B, and **5**C are diagrams illustrating a flow of the air in the state where the two scirocco fans of a coupling air duct for coupling the two scirocco fans have been coupled.

FIG. **6** is a diagram illustrating a construction of a loosening fan according to Comparison of the embodiment.

FIG. **7** is a diagram illustrating another construction of a loosening fan using the scirocco fans.

FIG. **8** is a diagram showing speed target values at the time of making rotational speed control of the loosening fan.

FIG. **9** is a control block diagram of the sheet feeding apparatus.

FIGS. **10**A, **10**B, and **10**C are diagrams for describing the rotational speed control of the loosening fan.

FIG. **11** is a diagram showing coefficients for sheet conditions.

FIG. **12** is a diagram showing an operation display screen for selecting the rotational speed control of the loosening fan.

FIGS. **13**A and **13**B are diagrams for describing the operation which is executed after the rotational speed control of the loosening fan was started.

FIG. **14** is a diagram showing a warning on the operation display screen in the case where the apparatus failed in the rotational speed control of the loosening fan.

FIG. **15** is a timing chart in a range from the start of the rotational speed control of the loosening fan to the normal end thereof.

FIG. **16** is a timing chart for describing the control which is made after the apparatus failed in the rotational speed control of the loosening fan.

FIG. **17** is a timing chart in the case where the rotational speed control for the four fans has normally been completed.

FIG. **18** is a diagram showing the state when a rotational speed of the fan is controlled by a PWM.

FIG. **19** is a flowchart for describing the rotational speed control of the four fans.

FIG. **20** is a schematic constructional diagram illustrating an example of a sheet feeding apparatus provided for a conventional image forming apparatus.

FIG. **21** is a first diagram for describing the sheet feeding operation of the sheet feeding apparatus illustrated in FIG. **21**.

FIG. **22** is a second diagram for describing the sheet feeding operation of the sheet feeding apparatus illustrated in FIG. **21**.

FIG. **23** is a third diagram for describing the sheet feeding operation of the sheet feeding apparatus illustrated in FIG. **21**.

FIG. **24** is a fourth diagram for describing the sheet feeding operation of the sheet feeding apparatus illustrated in FIG. **21**.

DESCRIPTION OF THE EMBODIMENTS

An exemplary embodiment for embodying the invention will be described in detail hereinbelow with reference to the drawings.

FIG. **1** is a diagram illustrating a schematic construction of a printer as an example of an image forming apparatus having a sheet feeding apparatus according to the embodiment of the invention.

In FIG. **1**, an image reading unit **130** for reading an original document (hereinbelow, simply referred to as an original) D put on platen glass **120**_a_ as a document setting base plate by an automatic document feeder (ADF) **120** is provided in an upper portion of a printer main body **101** of a printer **100**. An image forming unit **102** and a sheet feeding apparatus **103** for feeding the sheet S to the image forming unit **102** is provided in a lower portion of the image reading unit **130**. A photosensitive drum **112**, a developing unit **113**, a laser scanner unit **111**, and the like are provided for the image forming unit **102**. The sheet feeding apparatus **103** has a plurality of sheet enclosing portions **115** and adsorbing and conveying belts **611**. Each sheet enclosing portion **115** encloses the sheets S such as OHTs or the like and is detachably attached to the apparatus main body **101**. The adsorbing and conveying belt

611 is a feeding belt as an example of a sheet feeding unit for feeding the sheets S enclosed in the sheet enclosing portion **115**.

The image forming operation of the printer **100** with such a construction will now be described.

When an image reading signal is output to the image reading unit **130** from a control unit **603** (refer to FIG. **9**) provided for the apparatus main body **101**, an image is read out by the image reading unit **130**. After that, a laser beam corresponding to the image is irradiated from the laser scanner unit **111** onto the photosensitive drum **112**.

At this time, the photosensitive drum **112** has previously been charged. By irradiating the light onto the photosensitive drum, an electrostatic latent image is formed on the drum. Subsequently, by developing the electrostatic latent image by the developing unit **113**, a toner image is formed on the photosensitive drum.

When the feeding signal is output from the control unit **603** to the sheet feeding apparatus **103**, the sheet S is fed from the sheet enclosing portion **115**. After that, the fed sheet S is sent to a transfer unit constructed by the photosensitive drum **112** and a transfer charging unit **118** synchronously with the toner image on the photosensitive drum by a registration roller **117**.

Subsequently, the toner image is transferred to the sheet sent to the transfer unit in this manner. After that, the sheet is conveyed to a fixing unit **114**. Further, thereafter, the toner image is heated and pressed by the fixing unit **114**, so that a non-fixed transfer image is permanently fixed onto the sheet S. The sheet on which the image has been fixed as mentioned above is ejected from the apparatus main body **101** to a discharge tray **119** by an ejecting roller **116**.

FIG. **2** is a diagram showing a construction of the sheet feeding apparatus **103**. In FIG. **2**, a tray **602** which can be freely elevated upward and downward is arranged in a container **132** provided in the sheet enclosing portion **115**. A plurality of sheets S is stacked on the tray **602**. A lifter **604** for elevating the tray **602** upward and downward, a lower position detecting sensor **605**, and a sheet presence/absence detecting sensor **606** are provided for the container **132**.

The adsorbing and conveying belt **611** adsorbs the sheet and conveys it. An adsorbing fan **612** allows the adsorbing and conveying belt **611** to adsorb the sheet S. An air blowing unit **610** is an air blowing mechanism for blowing the air to a front edge surface as an edge on the downstream (front) side in the sheet feeding direction of the sheet bundle SA. A loosening fan **609** is provided in the air blowing unit **610**. A floating lower limit detecting sensor **607**, a floating upper limit detecting sensor **608**, and a retry sensor **620** are attached at positions illustrated in the diagram.

In the sheet feeding apparatus **103** with such a construction, when the user pulls out the container **132** provided in the sheet enclosing portion **115**, sets the sheets S therein, and thereafter, stores the container **132**, the tray **602** is lifted up by the lifter **604**. The tray **602** is stopped at a position where a distance between the upper surface of the sheet bundle SA and the adsorbing and conveying belt **611** is equal to a predetermined distance and, thereafter, prepares for the feeding signal.

Subsequently, when the feeding signal is input, the loosening fan **609** is made operative and sucks the air. The air is blown toward the front edge surface of the sheet bundle SA from a loosening nozzle **610***a* and a separating nozzle **610***b* which are provided for the air blowing unit **610** and shown in FIGS. **10**A, **10**B and **10**C, which will be described hereinafter. Thus, a few upper sheets in the sheet bundle SA float.

Subsequently, when a floating state of a plurality of floating sheets is stabilized after the elapse of a predetermined time after the feeding signal had been input, the top sheet Sb among the plurality of floating sheets is adsorbed to the adsorbing and conveying belt **611** by a sucking force applied from the adsorbing fan **612**.

By finally rotating the adsorbing and conveying belt **611** in the direction shown by an arrow, the sheet Sb is fed together with the adsorbing and conveying belt **611** and, thereafter, sent to the next conveying path by a pulling-out roller pair **136**.

FIGS. **3** and **4** are diagrams each illustrating a part of a construction of the loosening fan **609**, the loosening fan **609** is constructed by combining a plurality of fans. Two fans (scirocco fans) **51** and **52** are fixed to both side surfaces of a supporting base plate **50** so that their air blowout ports **54** and **55** face in almost the same direction, respectively. The air blowout port **55** of the fan **52** on the upstream side in the air flowing direction and an air suction port **56** of the fan **51** on the downstream side are coupled by a coupling air duct **53**.

FIG. **4** is a diagram for describing a flow of the air of the two fans **51** and **52**. Impellers (not shown) of the two fans **51** and **52** are rotated in the same direction shown by arrows AF in the diagram. The air sucked in the axial direction of the impeller from an air suction port **57** of the scirocco fan **52** on the upstream side is blown out from the air blowout port **55** in the directions shown by arrows FB in the diagram by the impeller of the fan **52**. The air passes through the coupling air duct **53** and is sucked to the fan **51** on the downstream side from the directions shown by arrows FC in the diagram. The air is blown out from the air blowout port **54** in the directions shown by arrows FD in the diagram by the impeller of the fan **51**.

FIGS. **5**A, **5**B, and **5**C illustrate a construction of the coupling air duct **53**. An arrow shows a flow of the air in the state where the two fans **51** and **52** have been coupled. An air inlet **501** of the coupling air duct **53** is formed so as to have a size matched with that of the air blowout port **55** of the fan **52** on the upstream side. To prevent an air leakage, the air inlet **501** has been sealed with a soft member **502** (hatched portion in the diagram) such as a sponge.

An air FB blown out of the fan **52** on the upstream side is guided to a counterclockwise spiral passage **504** of the coupling air duct **53** and sucked as an air FC of the fan **51** on the downstream side in FIG. **4**. The air sucked into the coupling air duct **53** is gradually converged in an inside **503** of the coupling air duct **53** so as to flow smoothly and is guided to the spiral passage **504**.

The spiral passage **504** is rotating counterclockwise and its height decreases gradually in the direction shown by an arrow Y in the diagram. By providing a cylindrical separating wall **505** at the center, the air FB is made to more efficiently circle. A rotational center of the spiral passage **504** coincides with a rotational center of the impeller of the fan **51** on the downstream side in order to smoothly guide the air.

By constructing the apparatus as mentioned above, the air blown out of the fan **52** on the upstream side flows smoothly into the fan **51** on the downstream side, thereby promoting the rotation of the impeller. Therefore, a compression efficiency of the air is improved and the air of a high pressure can be blown out.

FIG. **6** is a diagram illustrating a coupling construction of a loosening fan according to Comparison of the embodiment. In the case of this construction, rotating directions of the two fans (scirocco fans) **51** and **52** are the same as the direction shown by the arrow AF in FIG. **4**. However, the air FB from the fan **52** on the upstream side circles clockwise opposite to the direction mentioned so far by a coupling air duct **60** and flows into the fan **51** on the downstream side.

That is, the air flows in the direction opposite to the rotating direction AF of the impeller of the fan **51** on the downstream side. The wind pressure is measured under the foregoing conditions in this state, so that it has been found that the obtained wind pressure was decreased by about 10% as compared with that in the case of guiding the air in the same condition as the direction AF by using the coupling air duct **53**.

In order to obtain the high pressure by serially coupling the two fans **51** and **52**, therefore, it is proper to guide the air from the fan **52** on the upstream side in the same direction as the rotating direction of the impeller of the fan **51** on the downstream side by using the coupling air duct **53**.

Although the embodiment has been described with respect to the construction in which the two fans **51** and **52** are coupled, naturally, two or more fans can be coupled by using the same method as that mentioned above. Although the two fans **51** and **52** of the same ability have been coupled in the embodiment, fans of different abilities may be combined. In such a case, it is desirable that the fan having the higher ability is arranged on the upstream side.

In the embodiment, as illustrated in FIG. **7**, the loosening fan **609** is formed in such a manner that the two serially-connected fans are constructed as one unit and two such units are connected in parallel. That is, a unit **70** is formed by serially coupling a first fan **51***a* and a second fan **52***a* through the coupling air duct **60**. A unit **71** is formed by serially coupling a third fan **51***b* and a fourth fan **52***b* through the coupling air duct **60**. Those two units **70** and **71** are connected in parallel by air duct members **73**. Scirocco fans having substantially the same ability are used as those four fans **51***a*, **52***a*, **51***b*, and **52***b*. By constructing as mentioned above, the air of the high pressure can be obtained.

In the embodiment, a fan in which rotational speeds of the first to fourth fans **51***a*, **52***a*, **51***b*, and **52***b* constructing the loosening fan **609** can be monitored is used. Generally, in the fan whose rotational speed can be monitored (detected), in order to make rotational speed control of the fan, a target value is necessary. From characteristics of the fan, it has been found that in the case of rotating the fan at a predetermined PWM (Pulse Width Modulation) setting, a predetermined rotational speed (FG: Frequency Generation) is output and, at the same time, a predetermined wind pressure is obtained.

A method of setting the target value for making the rotational speed control of the loosening fan **609** illustrated in FIG. **7** will now be described. The case of controlling the rotational speeds of the loosening fans in a lump will be described here. In the embodiment, a wind pressure necessary to loosen all types of sheets which are used in the image forming apparatus is set to 840 Pa. The control unit **603** controls the loosening fan **609** so as to form the set wind pressure by combining the first to fourth fans **51***a*, **52***a*, **51***b*, and **52***b*.

Assuming that the first to fourth fans **51***a*, **52***a*, **51***b*, and **52***b* constructing the loosening fan **609** are the scirocco fans having substantially the same performance, it has been confirmed by experiments that when all of the fans are driven at 24V and the PWM of 100%, the necessary wind pressure (840 Pa) is obtained. The rotational speeds of the fans in this instance are set equal to, for example, 182 Hz for the first fan **51***a*, 171 Hz for the second fan **52***a*, 181 Hz for the third fan **51***b*, and 162 Hz for the fourth fan **52***b*, respectively.

The reason why the rotational speeds of the fans differ in the case of rotating the fans under the same conditions (24V, PWM of 100%) will now be described.

When the first fan **51***a* and the second fan **52***a* of the unit **70** are rotated at 24V and the PWM of 100%, the first fan **51***a* on

the downstream side is influenced by the wind pressure from the second fan **52***a* on the upstream side and rotates faster. On the contrary, the rotational speed of the second fan **52***a* on the upstream side is lower than that of the first fan **51***a* on the downstream side and becomes stable. In other words, in the case of driving the serially-coupled fans under the same conditions (24V, PWM of 100%), the rotational speed of the fan on the downstream side is higher than that of the fan on the upstream side.

In a unit in which a plurality of fans having substantially the same performance is serially connected, when a target rotational speed is set as shown by the following expression, the air is blown out at a efficient wind pressure.

(rotational speed of the fan on the downstream side)>
(rotational speed of the fan on the upstream side)

That is, it is proper to set the target rotational speed in such a manner that the rotational speed of the fan on the downstream side between the serially-coupled fans is higher.

When the first to fourth fans **51***a*, **52***a*, **51***b*, and **52***b* are controlled at 24V and PWM of 100% as references, there is a risk that they cannot be stably controlled due to a variation in performance of the fans. Therefore, a surplus voltage of, for example, 26.5V is applied to the fans and the value of the PWM is adjusted so that the rotational speeds of the fans can be controlled by the PWM. In this manner, the stable airflow amount can be obtained according to the variation of the fans.

For example, when the first to fourth fans **51***a*, **52***a*, **51***b*, and **52***b* are driven at 26.5V, as shown in FIG. **8**, in order to accomplish 182 Hz as a target value of the rotational speed of the first fan **51***a*, the PWM value is set to 92%. Similarly, in order to accomplish 171 Hz as a target value of the rotational speed of the second fan **52***a*, the PWM value is set to 87%. In order to accomplish 181 Hz as a target value of the rotational speed of the third fan **51***b*, the PWM value is set to 91%. In order to accomplish 162 Hz as a target value of the rotational speed of the fourth fan **52***b*, the PWM value is set to 82%.

In the embodiment, as shown in FIG. **8**, for example, the rotational speed of the first fan **51***a* is set so that its target value is equal to 182 Hz, an upper limit value of the target rotational speed is equal to 184 Hz, and a lower limit value of the target rotational speed is equal to 180 Hz. The rotational speed of the second fan **52***a* is set so that its target value is equal to 171 Hz, an upper limit value of the target rotational speed is equal to 173 Hz, and a lower limit value of the target rotational speed is equal to 169 Hz. The rotational speed of the third fan **51***b* is set so that its target value is equal to 181 Hz, an upper limit value of the target rotational speed is equal to 183 Hz, and a lower limit value of the target rotational speed is equal to 179 Hz. The rotational speed of the fourth fan **52***b* is set so that its target value is equal to 162 Hz, an upper limit value of the target rotational speed is equal to 164 Hz, and a lower limit value of the target rotational speed is equal to 160 Hz. By adjusting the PWM value so that the rotational speed of each of the fans is within a range of the target set values which have been set as mentioned above, the optimum airflow amount can be obtained.

As for the above target set value, the optimum value has been determined as an examination result in the construction of the invention. It is necessary to independently determine the optimum values for the target value, the target rotational speed upper limit value, and the target rotational speed lower limit value depending on the construction.

FIG. **9** is a control block diagram of the sheet feeding apparatus provided for the image forming apparatus of the embodiment. In FIG. **9**, detection signals from the retry sensor **620**, the lower position detecting sensor **605**, the sheet presence/absence detecting sensor **606**, a rotational speed detecting unit **600**, the floating lower limit detecting sensor **607**, and the floating upper limit detecting sensor **608** are input to a control unit **603**, respectively. The control unit **603** controls the driving of the loosening fan **609** and a lifter driving unit **604**A based on the detection signals from the sensors.

The rotational speed control of the loosening fan **609** will now be described with reference to FIGS. **10**A, **10**B, and **10**C.

When a transition signal to shift the operating mode to the rotational speed control of the loosening fan **609** is detected after a power source was turned on, after a predetermined number of sheets were conveyed by the sheet feeding apparatus **103**, or after the elapse of a predetermined time, the rotational speed control of the loosening fan **609** is started.

To enable the rotational speed control of the loosening fan **609** to be normally made, an obstacle must not exist on an extending line of the loosening nozzle **610***a* as an air blowout port through which the air is blown out by the loosening fan **609**. For example, when the sheet bundle SA stacked on the tray **602** exists on the extending line of the loosening nozzle **610***a*, since the air passage of the loosening fan **609** is shut off, the normal rotational speed, the normal airflow amount, and the normal wind pressure cannot be obtained.

Therefore, when the transition signal is detected, first, the control unit shown in FIG. **9** drives the lifter driving unit **604**A. Thus, as illustrated in FIG. **10**A, the descending operation of the tray **602** by the lifter **604** (refer to FIG. **2**) is started. As illustrated in FIG. **10**B, when the tray **602** is detected by the lower position detecting sensor **605**, the driving of the lifter driving unit **604**A is stopped, thereby stopping the tray **602**. If no sheets are detected by the sheet presence/absence detecting sensor **606** in this state, as illustrated in FIG. **10**C, the loosening fan **609** is driven so as to blow out the air and the rotational speed control of the loosening fan is started after the elapse of a predetermined time.

As mentioned above, after the rotation of the fan was stabilized after the elapse of the predetermined time, the rotational speed control is made and the PWM value is adjusted while monitoring (detecting) the rotational speed of the fan so that the rotational speed (FG) of the fan is equal to the predetermined value. As a method of controlling the rotational speed of the fan, there can be mentioned: a method whereby the PWM value is decreased every predetermined value after the fan was rotated at a duty of 100%; and a method whereby the PWM value is increased or decreased by a value obtained by multiplying a coefficient corresponding to a difference between the target value and the actual rotational speed.

By making the rotational speed control after the elapse of the predetermined time after the start of the operation of each of the fans **51***a*, **52***a*, **51***b*, and **52***b*, for example, the PWM values which are obtained after the fan rotational speed control was normally finished are set to 92% with respect to the first fan **51***a*, to 87% with respect to the second fan **52***a*, to 91% with respect to the third fan **51***b*, and to 82% with respect to the fourth fan **52***b* as shown in FIG. **8**, respectively.

The PWM values of the four fans **51***a*, **52***a*, **51***b*, and **52***b* in this instance are stored into a memory **601** as a storing unit shown in FIG. **9**. Although the case of the four fans has been described above, another plural number of fans can be connected. Initial speeds (PWM values) of the fans can be set to the same value or set to the optimum values, respectively. Further, the PWM value which is obtained after the previous rotational speed control was normally finished may be set to the initial speed.

It is necessary to adjust the PWM value according to the sheet type. The PWM value adjustment is performed by using coefficients according to the sheet types shown in FIG. **11**. FIG. **11** shows an example and the coefficients can be properly changed.

The control for adjusting the PWM value according to the sheet type is made after the normal end of the rotational speed control of the four fans **51***a*, **52***a*, **51***b*, and **52***b*.

In the apparatus, as shown in FIG. **8**, it is assumed that 840 Pa was obtained as a maximum wind pressure when the PWM values are controlled to 92% for the first fan **51***a*, to 87% for the second fan **52***a*, to 91% for the third fan **51***b*, and to 82% for the fourth fan **52***b*, respectively. The data of the PWM values has been stored in the memory **601**.

The PWM values stored in the memory **601** are adjusted according to the coefficients shown in FIG. **11** based on the sheet types. If thickest paper is selected, since the coefficient is equal to 1.0, the PWM value of the first fan **51***a* is set to 92%×1.0=92%, the PWM value of the second fan **52***a* is set to 87% ×1.0=87%, the PWM value of the third fan **51***b* is set to 91%×1.0=91%, and the PWM value of the fourth fan **52***b* is set to 82%×1.0=82%.

If thick paper is selected, since the coefficient is equal to 0.75, the PWM value of the first fan **51***a* is set to 92%×0.75=69%, the PWM value of the second fan **52***a* is set to 87%×0.75=65.25%, the PWM value of the third fan **51***b* is set to 91%×0.75 =68.25%, and the PWM value of the fourth fan **52***b* is set to 82%×0.75=61.5%, respectively.

If plain paper is selected, since the coefficient is equal to 0.5, the PWM value of the first fan **51***a* is set to 92%×0.5=46%, the PWM value of the second fan **52***a* is set to 87%×0.5=43.5%, the PWM value of the third fan **51***b* is set to 91%×0.5=45.5%, and the PWM value of the fourth fan **52***b* is set to 82%×0.5=41%, respectively.

If thin paper is selected, since the coefficient is equal to 0.25, the PWM value of the first fan **51***a* is set to 92%×0.25=23%, the PWM value of the second fan **52***a* is set to 87%×0.25=21.75%, the PWM value of the third fan **51***b* is set to 91%×0.25 =22.75%, and the PWM value of the fourth fan **52***b* is set to 82%×0.25=20.5%, respectively.

In this manner, by multiplying the coefficient according to the sheet type to the PWM value at the time of the maximum wind pressure, the air is blown out at the optimum wind pressure.

When the operation of a job is continued after the predetermined number of sheets were conveyed by the adsorbing and conveying belt **611**, the rotational speed control of the loosening fan **609** (fans **51***a*, **52***a*, **51***b*, and **52***b*) may be made after the end of the job or before the start of the job. As shown in FIG. **12**, the apparatus can be also constructed so that the user selects from an operation display screen whether or not the rotational speed control is made.

The operation which is executed after the rotational speed control of the loosening fan **609** was started will now be described with reference to FIGS. **13**A and **13**B.

In the embodiment, it is assumed that the fans **51***a*, **52***a*, **51***b*, and **52***b* are constructed so that the rotational speeds can be monitored. Information showing the rotational speeds are input from the fans to the control unit **603**. The rotational speed detecting unit **600** for detecting the rotational speeds of the fans **51***a*, **52***a*, **51***b*, and **52***b* may be provided as shown in FIG. **9**. When the rotational speed control of the loosening fan **609** is started, the control unit **603** as a control device makes a timer T operative and discriminates whether or not the rotational speed is within the target rotational speed range shown in FIG. **8** within a predetermined time. In this adjustment, if it is determined by the control unit **603** that there is a fan whose rotational speed is not within the target rotational speed range among the fans **51***a*, **52***a*, **51***b*, and **52***b*, the PWM value of the fan whose rotational speed is not within the target rotational speed range is adjusted.

If the rotational speed is within the target rotational speed range within a predetermined time after the start of the rotational speed control of the loosening fan **609**, the control is made so as to finish the rotational speed control of the loosening fan **609** and stop the loosening fan **609**. At the same time, the tray **602** is lifted up by the lifter driving unit **604**A. When the top surface of the sheet put on the tray **602** is detected by the floating lower limit detecting sensor **607**, the lifter driving unit **604**A is stopped.

If the rotational speed is not within the target rotational speed range within the predetermined time after the start of the rotational speed control of the loosening fan **609**, the control is made so as to finish the rotational speed control of the loosening fan **609** and stop the loosening fan **609**. Subsequently, as shown in FIG. **14**, a warning showing that the apparatus failed in the rotational speed control of the loosening fan **609** is displayed on an operation display screen. Although an alarm message is shown here so as to retry the rotational speed control of the loosening fan **609**, an error can be also displayed. The warning for the rotational speed control may be also displayed earlier than the operation stop timing of the loosening fan **609**.

In the embodiment, after the power source was turned on, after the predetermined number of sheets were conveyed by the adsorbing and conveying belt **611**, or after the elapse of the predetermined time, the rotational speed control (adjusting mode) of the loosening fan **609** is performed by the control unit **603** shown in FIG. **9**. That is, the sheet feeding apparatus of the embodiment has a mode for making the rotational speed control of the loosening fan **609**.

The number of sheets conveyed by the adsorbing and conveying belt **611** is counted by a counter **613** for counting the number of leading edges or trailing edges of a signal output of the retry sensor **620** or a pulling-out sensor (not shown).

The operation in the adjusting mode of the sheet feeding apparatus **103** will now be described with reference to a timing chart of FIG. **15**.

The operation of the sheet feeding apparatus **103** and the operation of the loosening fan **609** which are executed after the loosening fan **609** entered the rotational speed control mode, for example, after the power source was turned on, after the predetermined number of sheets were conveyed by the sheet feeding apparatus, or after the elapse of the predetermined time will now be mainly described. Although the active states of all signals in FIG. **15** are at the H (high) level (the detection is executed at H, the operation is executed at H, and the signal is valid at H), they may be also set to the L (low) level (the detection is executed at L, the operation is executed at L, and the signal is valid at L).

For example, when a start signal of the rotational speed control is set to H (made active) in order to enter the rotational speed control of the loosening fan **609** after the turn-on of the power source, first, the control unit **603** drives the lifter driving unit **604**A so that the tray **602** descends.

Subsequently, when the tray **602** reaches the lower position detecting sensor **605**, control is made in such a manner that the lifter driving unit **604**A is stopped, and if a no-sheet state is detected based on a signal from the sheet presence/absence detecting sensor **606**, the loosening fan **609** is driven.

Subsequently, the rotational speed control (adjusting mode) of the loosening fan **609** is started after the elapse of a predetermined time T**1** after the start of the operation of the loosening fan **609**. When the rotational speed control is started, the rotational speed of the loosening fan **609** is detected by the rotational speed detecting unit.

If the rotational speed of the loosening fan **609** is within a predetermined rotational speed range within a predetermined time T**2**, a normal end signal showing that the rotational speed control has normally been finished is output. Thus, the rotational speed control of the loosening fan **609** is finished and the operation of the loosening fan **609** is stopped.

In FIG. **15**, the rotational speed control is finished after the elapse of a time T**4** after the normal end signal of the rotational speed control had been output. However, it is also possible to control in such a manner that when the H-level state of the normal end signal has continued a predetermined number of times at regular intervals, it is determined that the rotational speed control has normally been finished. FIG. **15** shows the state where the rotational speed control has been finished within the predetermined time T**2**.

After the operation of the loosening fan **609** was stopped as mentioned above, the lifter driving unit **604**A is driven, thereby lifting the tray **602** up. When the presence of the sheet is detected by the sheet presence/absence detecting sensor **606**, the lifter driving unit **604**A is stopped and the tray **602** is stopped. Thus, the sheet feeding apparatus **103** enters the standby mode where the sheet feeding can be started any time in response to a sheet feed start signal.

It is proper that an elevation start timing of the tray **602** is within a time interval (T**3**) from the turn-on of the normal end signal of the rotational speed control to the turn-off of a fan driving signal. The timing in FIG. **15** is shown as an example. With respect to the transition states shown by arrows, the control mode can be shifted either at the same time or with a delay time.

Further, although the lifter driving unit **604**A is stopped based on the signal from the sheet presence/absence detecting sensor **606** after the tray **602** was lifted up, the lifter driving unit **604**A can be also stopped based on the signal from one of the floating lower limit detecting sensor **607** and the floating upper limit detecting sensor **608**.

The case where the apparatus failed in the rotational speed control of the loosening fan **609** will now be described with reference to a timing chart of FIG. **16**.

As already mentioned above, the rotational speed control (adjusting mode) of the loosening fan **609** is started after the elapse of the predetermined time T**1** after the start of the operation of the loosening fan **609** and the rotational speed of the loosening fan **609** is detected by the rotational speed detecting unit.

If the rotational speed of the loosening fan **609** is not within the predetermined rotational speed range within the predetermined time T**2**, the rotational speed control of the loosening fan **609** is finished and, at the same time, a warning showing the failure of the rotational speed control is displayed as shown in FIG. **14**. After that, control is made so as to stop the operation of the loosening fan **609**. As mentioned above, if the apparatus failed in the rotational speed control of the loosening fan **609**, the rotational speed can be also set by the previous PWM value stored in the memory **601** after that.

The rotational speed control in the case where the four fans **51***a*, **52***a*, **51***b*, and **52***b* (hereinbelow, referred to as **51***a* to **52***b*) according to the embodiment will now be described with reference to a timing chart of FIG. **17**.

When the control mode is shifted to the rotational speed control of the fans **51***a* to **52***b*, driving signals of the first to fourth fans (refer to FIG. **7**) are output and the first to fourth fans **51***a* to **52***b* start to rotate. However, activating timing for the first to fourth fans **51***a* to **52***b* may be set to the same timing or may have time differences among them.

Assuming that a time enough to allow all of the first to fourth fans **51**a to **52**b to reach a stable rotational speed is set to T**1**, a start signal of the rotational speed control of the first to fourth fans **51**a to **52**b is output after the elapse of T**1**. Thus, the rotational speed control is simultaneously started to the first to fourth fans **51**a to **52**b. When the start signal of the rotational speed control of the fans is turned on and the normal end signal of the rotational speed control of the first to fourth fans **51**a to **52**b is output within the predetermined time T**2**, the start signal of the rotational speed control of the fans is turned off. Thereafter, the driving signals of the first to fourth fans **51**a to **52**b are turned off after the elapse of the predetermined time.

A rotational speed control method of the fans in the embodiment will now be described based on FIG. **19**. Description will be made hereinbelow with respect to one of the first to fourth fans **51**a to **52**b.

In FIG. **19**, it is assumed that a center value of the target FG as a rotational speed of the fan is set to Ft, an upper limit value of the target FG is set to Fu, a lower limit value of the target FG is set to Fl, a current PWM value of the fan is set to Pc, a current FG value of the fan is set to Fc, and a fan correction coefficient is set to α. This fan correction coefficient is a coefficient for feeding back a difference between the target FG value and the current fan FG value to the current PWM value Pc of the fan.

A PWM value which is obtained after such a difference was fed back to Pc is assumed to be Pn. Now assuming that a feedback value of the fan to the PWM value is set to δ, the following equations are satisfied.

$$\delta = \alpha \times (Ft - Fc)$$

$$Pn = Pc + \delta$$

If Fc>Ft here, the feedback value δ is a negative value and control is made so as to decrease the rotational speed of the fan. If Fc<Ft, the feedback value δ is a positive value and control is made so as to increase the rotational speed of the fan. Further, if Fc=Ft, control is made so that the rotational speed of the fan is not changed. In this manner, the rotation of the fan whose adjustment is necessary is controlled by the new PWM value Pn.

The rotational speed control of the fans is made simultaneously or almost simultaneously to the first to fourth fans **51**a to **52**b. As a time necessary to perform the feedback, at least a time which is required until the rotational speed of the fan is stabilized after the adjustment of the PWM value of the loosening fan is necessary. Further, as for the correction coefficient α, it is necessary to set the feedback value δ to a value which can be fed back to the PWM value. If the feedback value δ is large, there is a case where the rotational speed of the fan is not settled. If the feedback value δ is small, there is a case where it takes a long time until the rotational speed control of the fan is finished. Therefore, it is necessary to set α to the optimum value.

The rotational speed control of the four fans **51**a to **52**b will now be described with reference to a flowchart of FIG. **20**.

The operation which is executed after the first to fourth fans **51**a to **52**b entered the rotational speed control after the power source was turned on, after the predetermined number of sheets were fed by the sheet feeding apparatus **103**, or after the elapse of the predetermined time will be mainly described.

When the fans enters the rotational speed control (Y in step S**101**), first, the first to fourth fans **51**a to **52**b are turned on (S**102**). Subsequently, after the elapse of the predetermined time after the operations of the first to fourth fans **51**a to **52**b had been started (Y in S**103**), the rotational speed control of the first to fourth fans **51**a to **52**b is started (S**104**).

Subsequently, the control unit discriminates whether or not the rotational speeds of the first to fourth fans **51**a to **52**b have been within the predetermined target rotational speed range within the predetermined time after the start of the rotational speed control of the first to fourth fans **51**a to **52**b (S**105**, S**110**). If the rotational speeds of the first to fourth fans **51**a to **52**b are not within the predetermined target rotational speed range (N in S**105** and Y in S**110**), the rotational speed control of the first to fourth fans **51**a to **52**b is finished. The first to fourth fans **51**a to **52**b are turned off (S**111**). Further, a warning showing the failure of the rotational speed control is displayed as shown in FIG. **14** (S**112**).

As mentioned above, when the apparatus fails in the rotational speed control, in order to prevent the operation of the sheet feeding apparatus **103** from being stopped, a predetermined value is set as a PWM value into each of the first to fourth fans **51**a to **52**b or to the fans **51**a to **52**b in which the apparatus has failed in the rotational speed control (S**113**). The previous PWM value can be also set as a PWM value which is set as mentioned above. After that, the set PWM values of the first to fourth fans **51**a to **52**b are stored into the memory (refer to FIG. **9**) (S**107**). If the rotational speed control of the first to fourth fans **51**a to **52**b have reached the values within the predetermined target rotational speed range within the predetermined time after the rotational speed control to the first to fourth fans **51**a to **52**b had been started (Y in S**105**), the rotational speed control of the first to fourth fans **51**a to **52**b is finished. The first to fourth fans **51**a to **52**b are turned off (S**106**).

The PWM values of the first to fourth fans **51**a to **52**b which have been set as mentioned above are stored into the memory (S**107**). After that, the PWM value of each sheet type is determined by using the coefficients (refer to FIG. **11**) allocated every sheet type as mentioned above.

In the above description, when the apparatus fails in the rotational speed control, the predetermined value is set as a PWM value or the previous PWM value is set. However, the invention is not limited to such a method. For example, when the warning indicative of the failure of the rotational speed control is displayed as shown in FIG. **14** (S**112**), subsequently, the value of the correction coefficient α mentioned above is automatically changed and whether or not the speed control is retried is selected (S**115**).

For example, if the rotational speeds of the first to fourth fans **51**a to **52**b are close to the target rotational speed range, the value of the correction coefficient α is automatically changed and the speed control is retried. If the change in the correction coefficient and the retry of the speed control are selected as mentioned above (Y in S**115**), the first to fourth fans **51**a to **52**b are turned on again (S**102**) and the rotational speed control is started.

As mentioned above, the rotational speeds of a plurality of fans **51**a to **52**b are controlled in such a manner that the wind pressure adapted to enable the sheets to be loosened in the state where all of the fans have been driven is obtained and the those rotational speeds are within the target rotational speed range which has been preset every plural fans **51**a to **52**b. Thus, the sheets can be certainly fed without being influenced by the aging change of the fan characteristics or the like and without causing the double feeding and a paper jam.

Although the embodiment has been described above with respect to the case of controlling the all of the first to fourth fans **51**a to **52**b individually, the invention is not limited to such a construction. For example, the control unit can control rotational speeds of at least two of the plurality of fans.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application Nos. 2006-135892, filed May 15, 2006, and 2007-097891, filed Apr. 3, 2007, which are hereby incorporated by reference herein in their entirety.

What is claimed is:

1. An apparatus having a sheet feeding apparatus for blowing an air to sheets stacked on a tray, loosening the sheets, and feeding the loosened sheet toward an image forming unit, comprising:

an air blowing mechanism which is constructed by combining a plurality of fans in order to blow the air to the sheets stacked on the tray;

a control unit which controls the air blowing mechanism so as to form a set wind pressure by combining the plurality of fans, the control unit controlling rotational speeds of at least two of the plurality of fans, individually, wherein the control unit controls rotational speeds of at least two of the plurality of fans of the air blowing mechanism so as to be equal to a target rotational speed set for each of the plurality of fans so that the set wind pressure can be obtained, wherein the control device discriminates whether or not the rotational speeds of the plurality of fans are within target rotational speed ranges which have been set for the plurality of fans, and wherein the rotational speeds of the plurality of fans are controlled by PWM control and if it is determined by the control device that the rotational speeds of the plurality of fans are not within the target rotational speed ranges, a PWM value of the fan whose rotational speed is not within the target rotational speed range is adjusted; and

a memory which stores the PWM values of the every plurality of fans at the time when it is determined by the control device that the rotational speeds of the plurality of fans are within the target rotational speed ranges,

wherein if it is determined by the control device that the rotational speeds of the plurality of fans are not within the target rotational speed ranges, the PWM value of the fan whose rotational speed is not within the target rotational speed range is set to the PWM value stored in the memory.

2. An apparatus having a sheet feeding apparatus for blowing an air to sheets stacked on a tray, loosening the sheets, and feeding the loosened sheet toward an image forming unit, comprising:

an air blowing mechanism which is constructed by combining a plurality of fans in order to blow the air to the sheets stacked on the tray;

a control unit which controls the air blowing mechanism so as to form a set wind pressure by combining the plurality of fans, the control unit controlling rotational speeds of at least two of the plurality of fans, individually, wherein the control unit controls rotational speeds of at least two of the plurality of fans of the air blowing mechanism so as to be equal to a target rotational speed set for each of the plurality of fans so that the set wind pressure can be obtained, wherein the control device discriminates whether or not the rotational speeds of the plurality of fans are within target rotational speed ranges which have been set for the plurality of fans, and wherein the rotational speeds of the plurality of fans are controlled by PWM control and if it is determined by the control device that the rotational speeds of the plurality of fans are not within the target rotational speed ranges, a PWM value of the fan whose rotational speed is not within the target rotational speed range is adjusted; and

a memory which stores the PWM values of the every plurality of fans at the time when it is determined by the control device that the rotational speeds of the plurality of fans are within the target rotational speed ranges,

wherein the PWM values of the every plurality of fans stored in the memory are corrected according to a type of sheet which is fed and the fans are controlled based on the corrected PWM values.

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